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DIRECT-CURRENT MOTOR AND GENERATOR TROUBLES

SUGGESTIONS FOR THE CARE OF DIRECT-CURRENT APPARATUS; CHARACTERISTICS OF THE VARIOUS TYPES OF MOTORS AND GENERATORS AND REMEDIES FOR ORDINARY TROUBLES

By Norman G. Meade

SUCCESSFUL OPERATION OF direct-current motors and generators depends to a large extent upon the operator's understanding of their proper care. A few general rules, if observed, will greatly reduce the danger of an accident or a breakdown; knowledge of the operating characteristics of the various types of machines is also important.

As direct-current motors and generators of similar types are practically alike in construction and details of windings, many difficulties encountered in their operation are inherent to both machines.

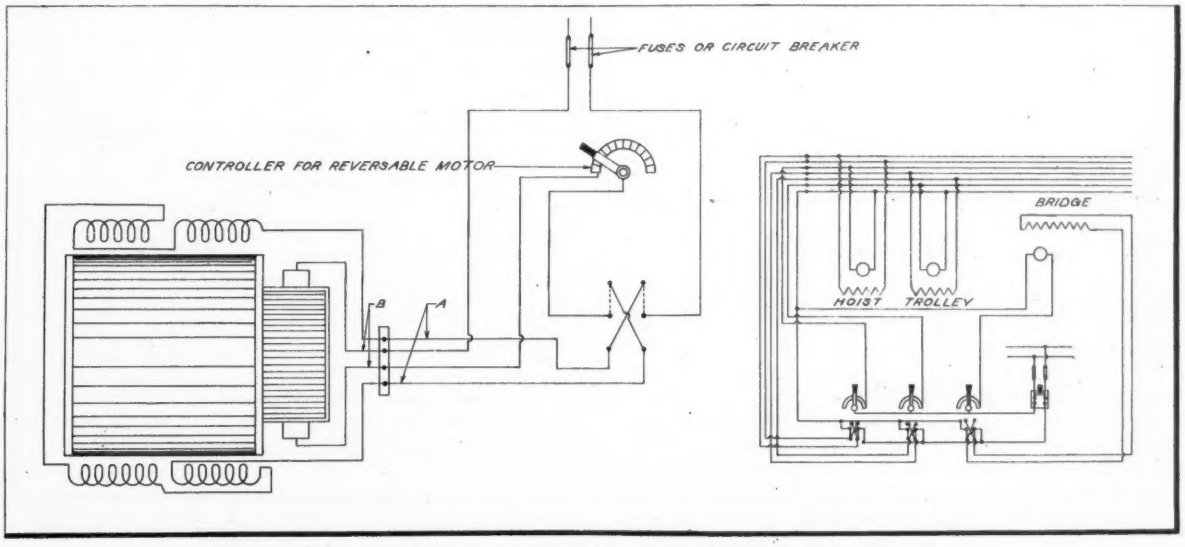


FIG. 1. (A) CONNECTIONS FOR SERIES-WOUND MOTOR AND ITS CONTROLLER
(B) CONNECTIONS FOR SERIES-WOUND MOTORS AS APPLIED TO AN ELECTRIC TRAVELING CRANE

Series-Wound Machines

THE series-wound generator formerly so extensively used for arc lighting purposes is now practically obsolete and will not be considered.

The series motor when operating without load, takes just enough current to make up for the losses within itself. As the armature increases in speed, the counter electromotive force increases and the current rapidly decreases. Since the field winding is in series with the armature winding, the flux is also decreased and the armature is still compelled to increase in speed in order to generate its counter electromotive force, which at no load about equals the impressed or line electromotive force. The no-load current is consequently small and the speed excessively high.

The characteristics of a series-wound motor may be summarized as follows: Its speed will vary through a wide range with changes of load; it will keep the power from changing greatly; it is notably sparkless; it has a very strong starting torque and will race if allowed to run free.

As the series-wound motor is especially adapted to the operation of electric traveling cranes, hoists, and turn tables, it is generally operated through a reversing and regulating controller. The diagram of connections is shown in Fig. 1.

In crane operation it often happens that the sagging of the trolley wires extending across the bridge of the crane will cause a short-circuit between the armature leads or the field winding leads as shown at B and A respectively. In the former case the trouble will at once be indicated by the locking of the armature, the field acting as a powerful brake.

Should the field windings be short circuited no torque will be exerted by the armature. A partial

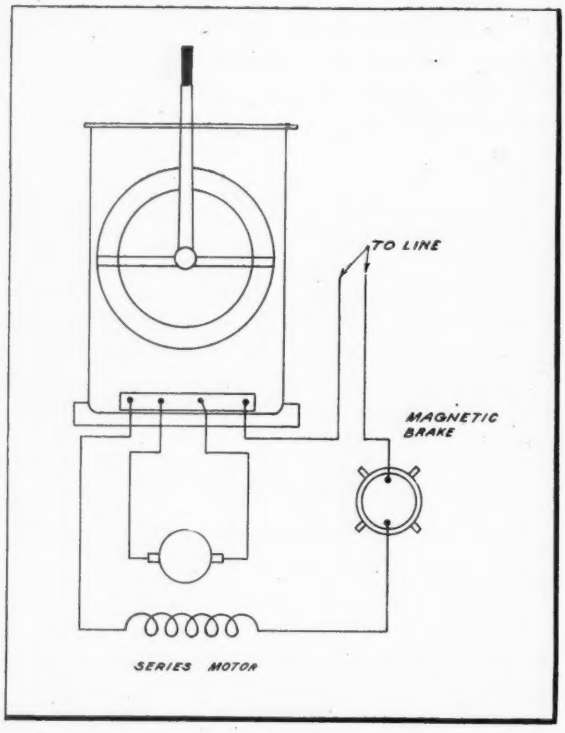


FIG. 2. SERIES MOTOR CONNECTIONS WITH BRAKE AND CONTROLLER

short-circuit, that is, one of high resistance, across either the armature or the field windings will cause excessive speed and reduction of torque.

Short-circuits in the controller resistance will cause irregular or "jerky" starting. An open circuit in the controller resistance will be indicated by a violent rush of current and a sudden jar as well as a flash of more or less intensity as the portion of the resistance cut out by the open circuit is passed and the controller fingers close the circuit through the motor.

It is necessary to provide the series motor, when operating a hoist or crane, with an automatic brake to stop it as soon as the current is shut off by either design or accident. These brakes are usually of the magnetic type, being so arranged that an electromagnet connected in series with the motor acts in opposition to a powerful spring and separates a rotating and a stationary friction disk, the former being attached to the motor shaft and the latter to the motor frame. The connections of a series-wound motor, a controller and a magnetic brake are shown in Fig. 2.

Shunt-Wound Machines

A SHUNT-WOUND motor and a shunt-wound generator are interchangeable, that is, either a generator may be used as a motor or vice-versa without disturbing the internal connections. It will be seen by reference to Fig. 3, that the relative direction of the current through the shunt-field winding is the same in both the motor and the generator.

A shunt generator will supply practically a constant voltage at its terminals over a wide range of loads

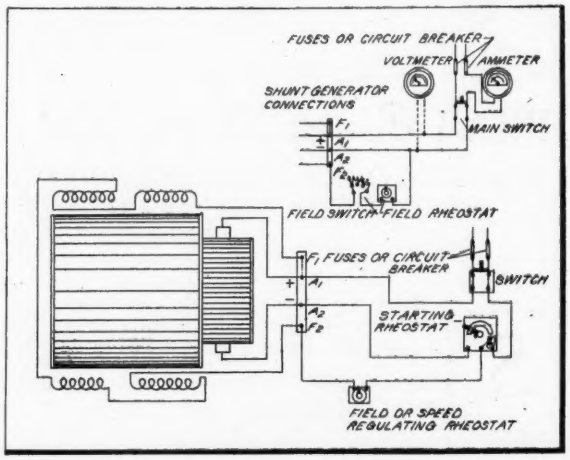


FIG. 3. CONNECTIONS OF SHUNT-WOUND GENERATOR AND SHUNT-WOUND MOTOR

and is suitable for small plants where the lines for light and power are short and the load not too suddenly varying. The voltage of the machine may be varied within certain limits by means of the field-regulating resistance.

The speed of a shunt-wound motor may be regulated within certain limits, depending upon the design. The method of regulation in common use is to

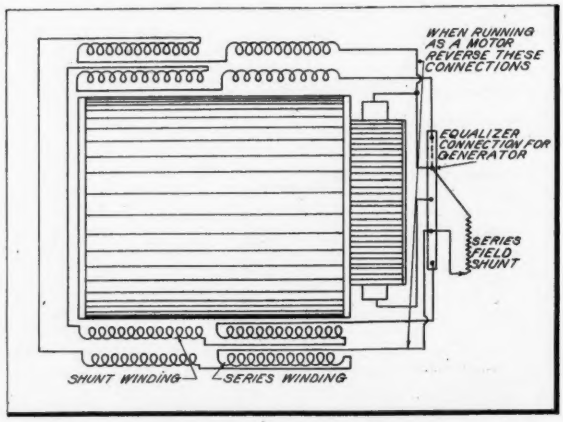


FIG. 4. COMPOUND-WOUND MOTOR OR GENERATOR CONNECTIONS

introduce resistance into the field circuit to increase its speed. By decreasing the amount of resistance in the field circuit the speed of the motor is correspondingly reduced.

Compound-Wound Machines

A COMPOUND-WOUND motor or generator, Fig. 4, is substantially the same as a shunt machine with the addition of a second field winding connected in series with the armature. The function of this wind-

ing in a generator is to raise the voltage above normal voltage under heavy loads in order to compensate for the drop in potential at the end of the line. The series coil has the characteristic of increasing the field magnetism above that at no load in a predetermined proportion in accordance with the increase of load. A shunt resistance is connected across the series field winding by which the current flowing through the winding, and consequently the percentage of overcompounding may be regulated.

A compound-wound motor possesses the characteristics of both a shunt and of a compound-wound

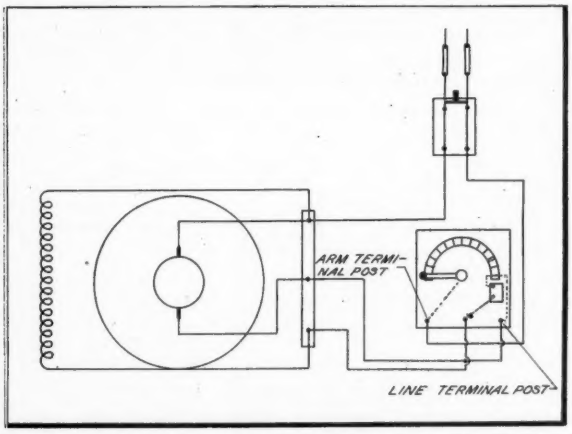


FIG. 5. TRANSPOSED ARMATURE AND LINE CONNECTIONS

motor, and its operation corresponds more nearly to one or the other, depending upon the relative proportioning of the 2 windings. The compound-wound motor will vary in speed with changes of load more than the shunt-wound motor, but will not race nor slow down under heavy load as much as a series-wound motor. It is well adapted to the driving of pumps,

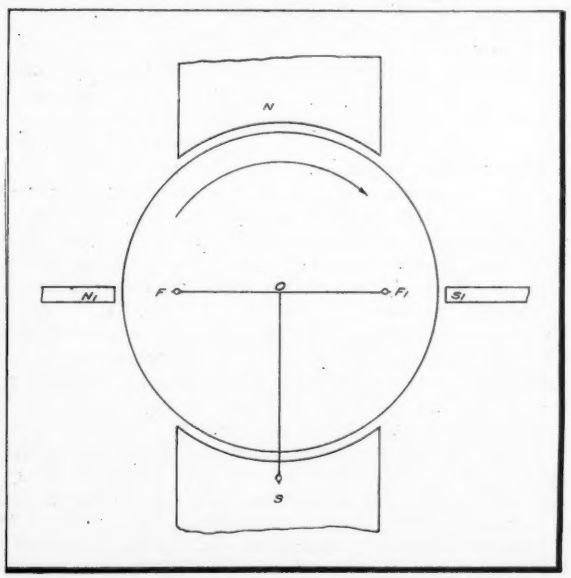


FIG. 7. DIAGRAM OF ACTION IN INTERPOLE MOTOR

fans of all kinds and all machinery requiring a fairly steady speed and a heavy starting torque.

A compound-wound machine may be operated either as a motor or as a generator by reversing the series-field winding as indicated in Fig. 4.

Wrong Connection of Starting Rheostat

A RATHER common and extremely aggravating error, in connecting up a shunt or a compound-wound motor is shown in Fig. 5, which consists of reversing the line and the armature lead at the starting rheostat. This interposes the resistance of the starting box between the shunt-field winding and the line and causes excessive and oftentimes disastrous speed with little or no starting torque. The correct connections were given in Fig. 3.

Interpole Machines

VARIABLE-SPEED motors designed for a wide range of speed and many generators are built at the present time with interpoles or commutating poles as diagrammatically shown in Fig. 6. The function of the interpole is to provide a flux opposite to and greater than the flux which produces the reactance voltage in each individual armature coil.

Figure 7 illustrates graphically the action of an interpole motor or generator. For simplicity a bipolar

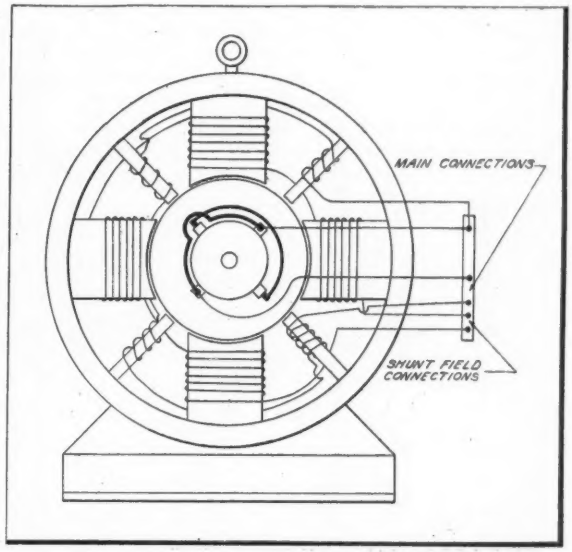


FIG. 6. DIAGRAM OF INTERPOLE MOTOR OR GENERATOR

model is shown. In the figure, N and S represent the main poles and N_1 and S_1 the auxiliary or interpoles The brushes on an interpole machine are set exactly on the theoretical neutral line. In the figure the vector, OF, represents the magnetomotive force of the main field poles both in direction and value. The force is constant for any given field excitement. OS represents the magnetomotive force due to the current in the armature and is directly proportional to the load, and were it not opposed and completely neutralized by the magnetomotive force OF_1, due to the current in the auxiliary field coils, the main field flux would be distorted and armature reaction result. The auxiliary winding, however, being in series with the armature winding, the magnetomotive forces OF and OF_1 will neutralize each other at all loads.

If any condition arises to negative the effect of one or more of the interpoles, the defect will usually manifest itself in local sparking at one or more of the brush studs, the commutation at the other studs remaining good. A short circuit of one of the commutating poles will act with this effect. The same trouble will be produced by the reversal of one interpole.

BOILER ROOM CALCULATIONS

FIGURING PROBLEMS BY ARITHMETIC AND BY SLIDE RULE

By Richard Howarth

WHETHER to use pencil and much brain matter, or the rapid and easily read slide rule, which requires only care in setting and reading, is a matter of personal preference. In either case the figures of coal weights, evaporation, pump performance, and so forth, show to the live engineer who wants to know just what his plant is doing. It seems best, therefore, in the series of problems to be considered in this and future articles, to give both methods so that choice may be had, and those who are not entirely at ease when handling the rule may check and compare results.

What The Slide Rule Is

VARIOUS forms and makes of slide rules are on the market, varying in size from 5 in. to 20 in. in length, but the 10-in. rule is the most convenient for engineers. It is a simple device consisting of the body, the slide and the runner, and is capable of performing practically any kind of calculation mechanically. For the ordinary operations of multiplying and

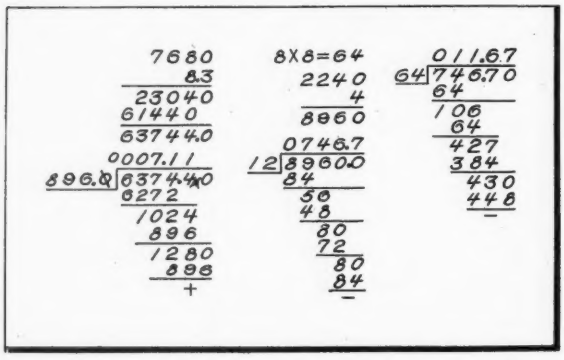


FIG. 2. CALCULATIONS FOR EVAPORATION PER SQUARE FOOT OF GRATE PER POUND OF COAL

dividing, the rule is simplicity itself. It is of course, impossible to learn the use of the slide rule without having one to practice on, so that the operation can be followed throughout, but when once mastered, the operator can do all his calculations from the coal pile to the switchboard in 1 per cent of the time that it takes by pencil and arithmetic, and with an accuracy sufficient for all practical purposes.

It is proposed, in this series of articles, to take the reader through all the uses of the rule, showing calculations from the simplest figuring of the boiler room to the most complicated engineering problems.

As seen in Fig. 1, there are 2 complete sets of scales called the A and B on the upper part, and C and D on the lower part. This lettering is simply for convenience in reference to the different scales. It will be noted that the A and B scales are numbered from 1 to 9, and then from 1 to 9 and to 1 again, while the C and D scales have graduations just twice as long as those on the A and B scales, and are numbered from 1 up to 9 and to 1. For instance, the distance from to 1 to 2 on the C and D scales reaches just twice as far from 1 to 2 on the A and B scales, or reaches as far as from 1 to 4 on the A and B scales.

The runner is not absolutely necessary in many problems but is a convenience both in locating positions on the scales and in transferring from the A and B scales to the C and D scales when using both sets in computation.

It should be noted that the numbered divisions as given on the scales refer only to the first significant figure, or in case of the division from 1 to 2 on the

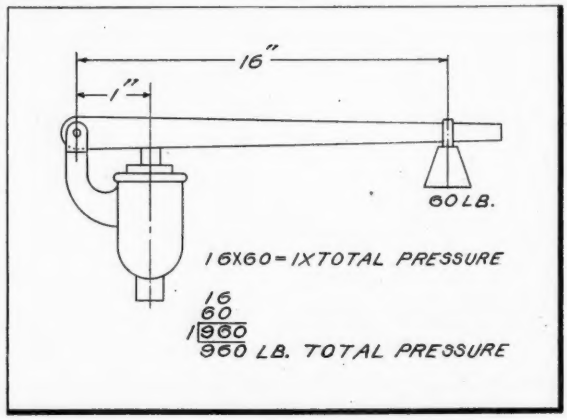


FIG. 3. SAFETY VALVE COMPUTATION

C and D scales, to the first 2 significant figures of the numbers with which we are working, so that the setting for 1, 10, 100 or 1000 will all be at the same position, and in making computations the real values of numbers must be kept track of as shown in the article in the December 1911 issue.

Simple Multiplication; To Get Weight of Coal

FOR a simple example in multiplication, suppose that 2 cars of coal have arrived, and according to the invoice, each contains 40 long tons. What is the total number of pounds in both cars?

By arithmetic this is evidently a simple problem of multiplying 40 by 2, and the product by 2240. It is so simple as not to require further comment. In the case of the slide rule, and remembering that the cipher of the 40 has no influence on the product of 2 times 40, except to determine the position of the decimal point, working with the A and B scales, we move the slide to the right until 1 on B comes under 4 on A; over 2 on B appears 8 on A, and as we have considered 1 on the rule as having the value of 10, then this 8 must have the value of 80.

In order to get this to pounds, we had to multiply 80 by 2240. We therefore move the slide to the right until 1 on B is under 224 on A, which in this case has a value of 2240; over 8 on B appears the reading 1792 as shown in Fig. 1, the runner not having been used in this calculation.

If the question arises how this reading is determined, it must be remembered that between 1 and 2 on the A scale there are 10 subdivisions, and that these are read as 1, 2, 3 and so forth the same as if they were numbered. Then, between the 7th and 8th division mark there are 5 divisions which would be read

as 2, 4, 6, 8; intermediate, or 1, 5, 7, 9, being represented by the positions half way between the lines shown on the rule. Where, as in the present case, the reading does not come exactly on 2, 4, 6, 8, or 1, 3, 5, 7, 9, the over amount must be estimated as accurately as possible.

The method of keeping track of the actual value of the result is explained in the article in the December 1911 issue, and consists of an approximate calculation; as for instance 80 times 2000 is 160,000, shows that the product read is 179,200. This is the total pounds of coal in both cars.

Coal Per Square Foot of Grate and Evaporation Per Pound of Coal

WHAT is the amount of water evaporated per square foot of grate area and per pound of coal when the meter on the feed line shows 7680 gal. used in 12 hr. and 4 tons of coal have been burned in a fire box 8 by 8 ft.?

We have first to find the total weight of water evaporated; a gallon of water weighs 8.3 lb., so that we multiply 7680 by 8.3, which by arithemetic we find to be 63,744. We wish also the square feet of grate area, which will be 8 times 8 or 64 sq. ft., and the number of pounds of coal burned, which will be 2240 times 4, or 8960 lb. The coal per hour will be 8960 divided by 12 or 746.7 lb.

Then to get the evaporation per square foot of grate per hour, we divide 746.7 by 64, giving 11.67 lb. per square foot of grate per hour.

To get the evaporation per pound of coal, we divide the total water used by the total coal used or 63,744 by 9860, giving, 7.11 lb. of water per pound of coal.

Taking now the process by use of the slide rule, to multiply 8 by 8, we place 1 on B under 8 on A, and over 8 on B find 64 on A. If we examine the arithmetical computation, Fig. 2, we shall find that there are several continuing operations. First we have multiplied 2240 by 4 to get the total coal, then divided by 12 to get the pounds per hour and then by 64 to get the pounds per sq. ft. of grate. These operations may all be combined on the slide rule as follows:

Set 1 on B to 224 on A as seen in Fig. 1, and over 4 on B will be found 896 on A; we then bring the runner to this point and bring 12 on B to the hair line on the runner, over 1 on B will be found 747 on A which is the quotient; but this is to be divided by 64, hence, we bring the runner to the 1 on B, then bring 64 on B to the runner, and above 1 on B, we shall find 1167 on A. To locate the decimal point we should have that 1000 times 4 would be 8000, divided by 10 would be about 800, and 800 divided by 64 would be something over 10 so that the answer is 11.67 lb. evaporation per sq. ft. of grate per hour.

To get, now, the evaporation per pound of coal, we set 1 on B to 768 on A, and over 83 on B we find 637 on A; this is to be divided by the total weight of coal 8960, hence, we set the runner to 637 on A, the point already found, and bring 896 on B to the mark on the runner; over 1 on B we find 711 on A, and to find the decimal point we figure that 7000 times 8 would give us 56,000 which divided by 8000 would give us 7, therefore the value is 7.11 lb. of water evaporated per pound of coal.

In practice the student will find that as he goes on the rule becomes familiar to him and the different values of the settings will come to him automatically, so that the knowledge which he gains will make it ever easier to go on, and will be an incentive to improve himself further.

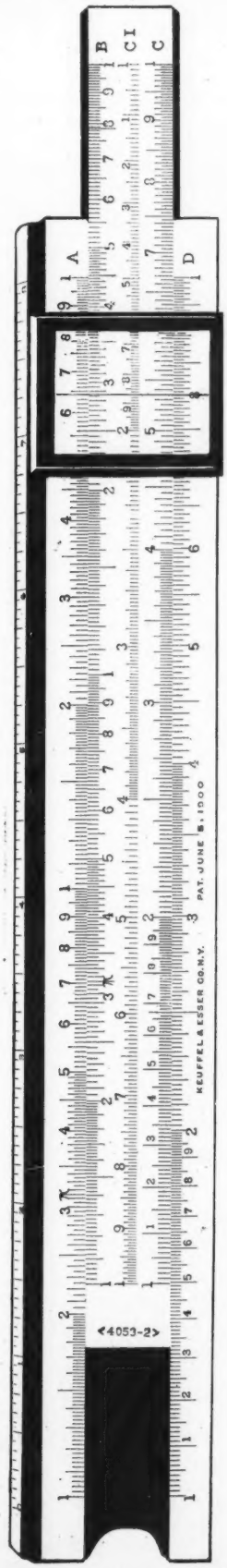


FIG. 1. SETTING OF RULE FOR MULTIPLYING 2240 BY 80 ON THE A AND B SCALES

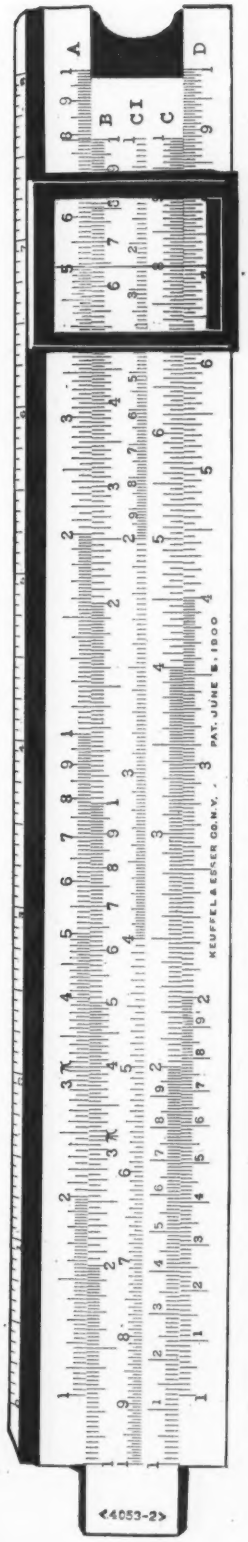


FIG. 5. RULE SETTING TO FIND AREAS

Safety Valve Problem

IF a safety valve lever has a weight of 60 lb. at 16 in. distance from the center of the weight to the fulcrum, and the distance from fulcrum to the center of the valve is 1 in., what is the total force exerted on the valve stem, due to the weight?

We have in this problem that the weight times its distance from the fulcrum is equal to the pressure on the valve times its distance from the fulcrum, or 16 times 60 equals the pressure times 1. We then have 16 times 60 equals 960, divided by 1 equals 960 lb., the total pressure on the valve.

Using the C and D scales, we place 1 on C at 16 on D, and under 6 on C we find on D; the division

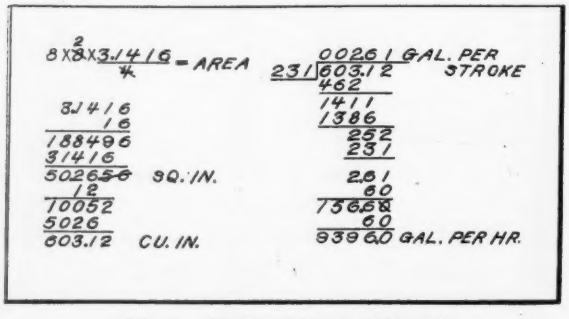


FIG. 4. PUMP CAPACITY PROBLEM

would be performed by bringing 1 on B to 960 on D, but we should of course find under 1 on C the 960 on D, so that it is not necessary to perform this division. This neglects of course the weight of the valve and spindle and of the arm, which should properly be

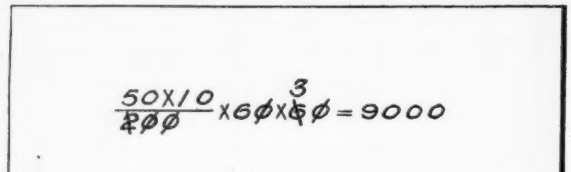


FIG. 6. CHECKING OUT FOR DECIMAL POINT

added to the above 960 lb., to get the total pressure which the valve will hold.

Pump Capacity

A SINGLE acting boiler feed pump 8 by 12 in., runs at 60 r.p.m. What amount of water is delivered per hour, neglecting slip of the valves? We have to find the number of cubic inches pumped per stroke which will be found by multiplying the area of the piston by the stroke. To get the area we have the rule that area equals square of the diameter times 3.1416, divided by 4. Expressing this multiplication and division, we can cancel the 4 into 1 of the 8's, and then 2 times 8 is 16, which we multiply by 3.1416, giving 50.26 sq. in. This multiplied by the length, 12 in. gives 603.12 cu. in. pumped per stroke. As there are 231 cu. in. per gallon we divide 603.12 by 231, giving 2.61 gal. per stroke This has to be multiplied by 60, the strokes per minute, and again by 60 the minutes per hour, giving 9396 gal. per hour.

To make the computation by use of the rule, we can of course perform all the operations straight through as indicated in the arithmetical problem, but a simpler way of finding the area is to set 14 on B under 11 on A; then above any diameter on C will be found corresponding area on A. In many rules there will be found between 78 and 79, on the right hand portion of scale A, a long mark which indicates where the right hand index of scale B is to be set in order to give the same setting as that by putting 14 on B under 11 on A.

Letting the slide rest as shown in Fig. 2, move the runner to 8 on C, and above this on A will be found 5026. We then bring 1 on B to the runner at the point 5026 on A, and carry the runner to 12 on B giving us 603 on A. Then to divide by 231, we bring 231 on B to the runner. and above 1 on B we find 261 on A. To multiply by 60 we bring the runner to 6 on B which gives us 1567 on A, then bring 1 on B to the runner and carry the runner again to 6 on B, giving us practically 94 on A.

To determine the actual value of this number, we can tell that the area is about 50 sq. in., because for an 8 in. square the area would be 64 sq. in., and for a circle it must be somewhat less. We then have 50 times 10 in place of 12, divided by 200 in place of 231, and multiplied by 60 and by 60. Setting this down and cancelling 2 ciphers of the 60's with the 2 ciphers in the denominator, the 2 in the denominator into a 6 in the numerator, we have, 50 times 10 is 500, times 6 is 3000, times 3 is 9000, which shows us that the value read is 9400. The actual value by arithmetical computation is 9396 per hour, and it may look at first sight as if we had lost 4 gal., but when we figure that the 4 gal. error in a total of 9396 is .4 of 1 per cent and that we usually allow from 10 to 20 per cent slip in a pump it is evident that the error in computation by the use of the slide rule is so small as to be of no consequence.

OILING LOW-PRESSURE CYLINDER

FREQUENTLY it happens that there is trouble in maintaining lubrication in the low-pressure cylinder of an engine, even when the high-pressure cylinder is all right. This arises because in the low-pressure, especially if the engine is running for a considerable time on a light load, the steam contains more water than in the high-pressure, and the oil is therefore washed off of the cylinder walls rapidly. Unless the oil for the cylinder under this condition, is properly compounded with animal oils, it will not maintain a film on the cylinder walls, and it frequently happens that properly compounded oil, costing much less than that in use, will remedy the difficulty. Where the high-pressure cylinder seems to be lubricated properly but the low-pressure is giving trouble, this expedient is always worth trying.

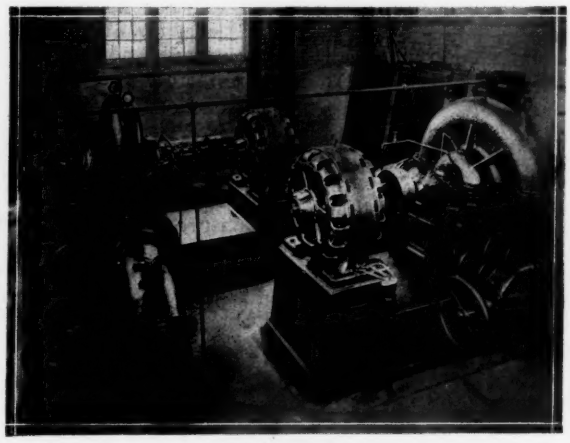
Another feature which sometimes causes difficulty is the introduction of the oil at the wrong point. Occasionally it is necessary to introduce the oil farther from the cylinder so that it may mix more thoroughly with the steam, and in other cases it is necessary to move the point of introduction nearer to the cylinder. Experiment is the only thing which will settle this point.

In regulating the supply of cylinder oil it should be carried at the point which gives the best results, everything being considered. It is not economy to save in the cost of lubricating oil and at the same time increase the friction of the engine to such an extent that the power secured costs more for coal than the saving in oil. This point can usually be settled by testing up the friction load of the engine with the indicator when different rates of feed are being used.

GRAND RAPIDS SEWAGE DISPOSAL PLANT

GRAND RIVER, which flows through the city of Grand Rapids, Mich., has caused considerable expense to the city by overflowing during flood periods, and by causing the sewers to back up. The river has but a small drop between Grand Rapids and Lake Michigan, and the current is therefore not rapid, even in the flood stages, thus preventing the quick running off of the drainage water. In summer the stream can be waded without difficulty, but when the spring thaws come the stream often rises 15 to 20 ft. in a few hours.

The sewage system of the city discharges into this river from 4 principal sewers. At flood stages these sewers are considerably below the water level; hence the river backs up through them, flooding the basements in all of the buildings in the lower section of the city, which includes the principal business section. So much heavy damage has been done in the past that steps had to be taken to prevent the possibility of its recurrence. The work is now practically completed.



ONE OF THE GRAND RAPIDS SEWAGE PUMPING STATIONS

The river has been dredged through its entire course in the city and the banks lined throughout practically the entire distance, by reinforced concrete walls averaging 20 ft. in height, which prevents the stream from overflowing. The water is prevented from backing up by valves in the sewers by which the discharge opening is entirely closed. To force the sewage into the river against the higher head during flood stages, large centrifugal pumps are installed at the mouth of each sewer and the piping arranged so that with the normal water level the sewage discharges directly into the river without the use of the pumps; but in flood periods the discharge valve is closed and the sewage discharges into a sump pit, from which it is pumped over the wall into the river. Three stations have already been built and the equipment has already been used a number of times. In one of the stations 2 large pumping units are installed, in the other 2 there are 3 units, while the fourth, when completed, will have 4 large units.

Pumps used are 12-in. centrifugals with capacity of 4300 gal. per min. against 10-ft. head, requiring 30-hp. motors; 18-in. centrifugals, 12,000 gal. per min. capacity against 3-ft. head and 30 hp.; 24-in centrifugals of 17,000 gal. capacity against 10-ft. head and 75 hp. and a 40-in. centrifugal of 47,000 gal. capacity against 7-ft. head, and 175 hp. Vacuum pumps are used for priming, having 12 cu. ft. per min. capacity for the smaller centrifugals and 2½-hp. motors and 36 cu. ft. capacity for the big pump requiring 6 hp.

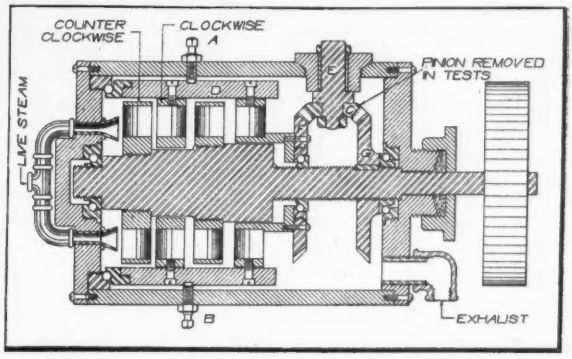
The power is supplied from the circuits of the Grand Rapids, Muskegon Power Co., so that the attendance required in the stations is only when there is danger of flood. Then the attendant goes to the station, throws in the main line switch, and closes the discharge valve. When the sewage level reaches a predetermined point, the attendant starts the pumps and runs them till the river falls, so that the sewage can discharge by gravity. When the flood is over, the attendant opens the discharge valves and shuts the motors down entirely; after what slight cleaning may be needed, the station is closed until the next flood.

Although one man at each station could readily perform all the work required, two men are always on duty during floods, to insure operation in case of an accident to one employee.

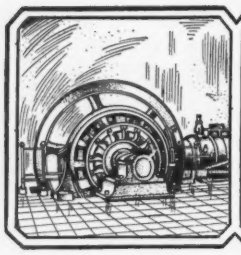
The pumps were supplied by the Buffalo Steam Pump Co. and the motors and electrical equipment by the Westinghouse Electric & Manufacturing Co.

NOVEL IDEA IN A STEAM TURBINE

HEREWITH is shown the sketch of a turbine which was built and has been tested for experimental purposes. The idea was that the ordinary set of stationary guide plates does no work, whereas if the re-action in these guide plates could be used to assist in doing work, permitting them to rotate in the opposite direction and connecting to the drive shaft through gears, better efficiency would be obtained. Arrangement is made so that when the set screws A and B are screwed home, as shown in the sketch, the guide plates are stationary, the same as in the ordinary form of turbine. When these are loosened, the guides are free to revolve. They are carried in a casing which at the end is geared through the bevels F, C and G, to the same shaft on which the wheels are mounted. Tests were made of the turbine in both operating conditions, and it was found that when both sets of wheels were allowed to rotate, the power generated was a little less than half the amount generated when one set was held stationary. The designer of this form is still testing on the arrangement, as he feels that much power must have been lost in the transmission through the gears. The ideas of the readers are in order as to the value of the method.

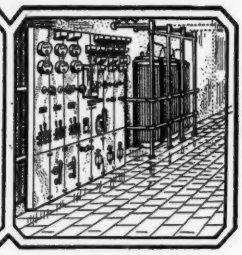


EXPERIMENTAL STEAM TURBINE WITH GUIDE BLADES REVOLVABLE



Electrical Machinery

For Generating, Transmitting and Using Current



ELECTRICAL ACCIDENTS AND THEIR TREATMENT

By Chas. A. Lauffer

ELECTRICAL injuries, based on their causes, may be classified as due to exposure to flashes and to actual contact. Flashes or arcs occur upon breaking, or momentarily short-circuiting, direct and alternating currents, as for example, where a switch in a heavily loaded circuit is opened by mistake or when a workman at a switchboard allows his screw driver to slip and causes a short-circuit. Although electrical flashes are ordinarily of only momentary duration, the heat developed is often intense. Painful burns of the unprotected skin or eyes may also result from continued exposure to the rays of an electric arc such as is used in arc welding, although the operator may not have been close enough to the arc to feel any intense heat. Such burns usually do not become apparent until several hours after the exposure. Their treatment is the same as for heat burns.

Injuries to the Eyes from Flashes

EYES which have been exposed to electrical flashes become very red; the suddenly dilated blood vessels of the mucous membrane of the eyes, on both the eyelids and the eyeball, become much congested. There is a copious secretion of tears, aversion to light, and intense pain. Often the hair is singed and charred hair, skin debris and dust particles may fill the eyes, contributing to the above symptoms. The mucous membrane covering the eyeball and the eyelids adjacent to the eyeball, which is known as the conjunctiva, is inflamed, constituting a "conjunctivitis." In more marked cases, there appears around the central transparent area of the eyeball, known as the cornea, a zone of red; such a zone of red in the white of the eye, near its junction with the colored part of the eye (the iris), is known as an "iritis," and is characteristic of a congestion of the blood vessels within this portion of the eyeball. If the heat of the flash is sufficient, as in the more severe cases, the superficial layers of the transparent cornea are coagulated.

The immediate treatment consists in washing the region of the eye and eyelids with eye-water,* then washing the eye itself. Upon dropping into the eyes a sufficient quantity of 3 per cent cocaine hydrochloride solution, the debris may be mopped out with clean cotton wrapped on a toothpick. The coagulated tissue of the cornea is similarly mopped off.

Immediate relief of pain is secured by cold compresses over the eye, and the chief remedy in the subsequent treatment is cold compresses; merely cotton or a clean cloth laid on ice, or made wet in ice water, and changed by the patient every 2 minutes. The cold compresses serve to contract the dilated blood vessels, and thus control the painful congestion. They can be employed for an hour at a time, as the patient lies down; not constantly, but every other hour. This enables the patient to get some sleep, for flashed eyes are most painful when he is relaxed and ready to sleep.

Eyewater is used every hour. In severe cases adrenalin hydrochloride, 1:5000 solution, is used every half hour; atropine sulphate, one per cent solution, a few drops every 4 hours to control the iritis referred to above, if this symptom manifests itself. Also it may be necessary to apply castor oil every 2 hours, to prevent the eyelids and eyeball from growing together, if the corneal tissue has been much injured. In the milder flashes the last 3 mentioned remedies are omitted, as the patient wears smoked glasses and returns to work in 2 or 3 days. Recovery is prompt and complete in practically all cases.

The fire of the flash that singes the hair or burns the skin is but one element in the production of this type of injuries, as the eyes may be "flashed" and present the congestion, watering, pain and aversion to light (the cardinal symptoms of flashed eyes), when the person is too remote from the heat of the flash to be burned. As suggested above, the intense light of the electric welding arc will produce a similar conjunctivitis and iritis; the effect probably being due to the ultra-violet rays present in the electric arc; but the red and blue glasses worn in the helmets of the welders protect them from the high intensity light.

Flashes Causing Injury to the Skin

FLASH burns of the skin are usually burns of the second degree. That is to say, while destroying the outer layer of the skin they do not injure the inner layer of the skin nor the deeper tissues. At first these burns may present a mere congestion; the skin is red, as from exposure to the sun, and they have the appearance of a first degree burn, scarce worth while dressing and bandaging. But there is pain, some redness, and by the second day huge blisters may have formed. Usually the hair is scorched; often the outer skin is blown off, and the surface looks ragged.

Under proper treatment of these cases, there is seldom any formation of pus, and they will heal up, usually without leaving a scar. We have treated men whose features were so altered by burns, and the eyes so swollen shut, that their own mothers would not have known them. To the uninitiated, it seemed they were scarred for life, yet within 2 weeks they were able to resume work, and within 2 months no trace of their burns was discernable.

*A serviceable formula for eye water is as follows:

Sodii Biboric	0.30
Acidi Boric	0.15
Alumini Sulphatis	0.06
Zinci Sulphatis	0.06
Aquae Camphorae	30.

Use freely as an eye wash.

With sleeves rolled up to the elbow, no gloves and the face near a switch when it is opened on a circuit carrying a heavy current, the exposure to flash burns is unnecessarily increased.

Immediate treatment of flash burns consists in securing the highest possible degree of surgical cleanliness with ethereal soap* applied with numerous cotton sponges (using sterilized absorbent cotton such as is sold for medical uses), and the application of a sterile gauze dressing, well covered with unguentine. We find this ointment uniformly reliable; it soothes the pain and promotes recovery. A loose gauze bandage is applied, and the part put at rest.

The subsequent treatment consists of daily redressings. When the blisters are large, scissor them open freely, but allow the outer skin to remain for some days, as it is in itself a splendid protective covering.

These burns must be washed clean, then there is little liability of infection with its pain, the formation of pus, and the resulting long term of disability. But should it become infected, and pus form, trim away the skin debris at once, so as to allow no pockets for the retention of infection. In the absence of infection, that is, when the pus-producing bacteria do not invade the wound, the dead skin is removed within a few days, after the inner sensitive layer of the skin has had a chance to harden somewhat, and to lose its sensitiveness.

When the healing has progressed we sometimes apply ten per cent Ichthyol in Petrolatum, to facilitate the formation of normal skin. After recovery, in most cases, the skin remains red and sensitive for some weeks. The patient should wear canvas gloves, and otherwise protect the new skin from grime and weather, as it is prone to eczema.

The dry open method of treating such burns, namely, that of powdering on Stearate of Zinc freely and exposing them unbandaged to the air, is successful in hospital practice, but not adapted to patients who may go on the streets, and who may return to work before complete recovery.

Contact Injuries

TWO types of contact injuries are shocks and burns.

The passage of an electric current through the human body may cause a momentary unpleasantness, the retention of the victim within the circuit unable to release himself, a suspension of consciousness during which he falls, but revives again, or a suspension of animation, requiring artificial respiration.† The artificial respiration helps sustain the action of the heart, hence the necessity of immediate efforts at resuscitation.

*A good formula for ethereal soap consists of:

Ether	4 oz.
Turpentine	1 oz.
Alcohol	3 pints.
Soft Soap	4 lbs.
Water enough to make 1 gallon.	

This soap is especially suitable for cleaning burns and wounds, as it serves to cut the dirt and grease, and at the same time renders the region antiseptic.

†In the prone pressure method of resuscitation from electric shocks and drowning the 3 essentials for performing artificial respiration are:

1. The man is laid upon his stomach, face turned to one side, so that the mouth and nose do not touch the ground.
2. The operator kneels, straddling the patient's hips, or kneels by either side of the hips, facing the patient's head.
3. The operator places his spread hands upon the lower ribs of the patient and throws his own body and shoulders forward, so as to bring his weight heavily upon the lower ribs of the patient. The operator's downward pressure should occupy about 3 seconds, then his hands are suddenly removed. Squeezing the chest in this manner forces the air out of the lungs. On release of the pressure the elasticity of the chest walls causes them to expand, and the lungs are refilled with fresh air. This act should be repeated indefinitely at the rate of about twelve times a minute. Any evidence of returning breathing should encourage the operator to continue his efforts. It often requires one-half hour to two hours.

Burns from electrical contact are generally of the third degree; that is, there is a destruction of both layers of the skin, and even of the deeper tissues. The real extent is not immediately apparent. The tissues are coagulated, and there is a deep white slough that is slow in separating. At times, fingers are burned to a cinder.

As a rule these burns are painless, and upon recovering from the shock the patient may not consider himself burned, but later discovery is made. In the milder forms they may not report for treatment until some days after the accident, by which time the burn has become infected. But these burns are worse than they look and are obstinate to heal, especially after infection sets in. Ordinarily, in the milder cases, the patient is best treated while continuing at work. In the severer degrees, as above mentioned, they are hospital cases.

Treatment in case of such burns consists in surgical cleanliness, secured by ethereal soap applied with numerous cotton sponges. For the milder burns, we prefer Deplettol or 10 per cent Ichthyol on sterile gauze, to facilitate the separation of the dead tissues. When the slough has separated, we commonly employ Balsam of Peru as a dressing and alternate with Thymol Iodide at times. When crusts form under this mode of treatment, we employ zinc oxide ointment to remove them, and continue with the daily dressings until the defect has granulated in and the area is covered with healthy skin.

Severer burns in hospital practice are treated by open dry or wet methods, in accordance with the ideas of the surgeon on the particular service. It is customary to be conservative in waiting for gangrene to demark the dead tissues, rather than resort to immediate amputations, inasmuch as the boundaries of the damaged tissues cannot be determined immediately. Burns of the palms, which to the uninitiated seem trivial, may necessitate the amputation of the hands, due to necrosis of the tendons.

While such accidents are relatively few, yet despite all precautions some will occur. It is the function of the surgeon to restore the victim of an electrical accident to normal, and not entirely in his province to know the voltage that has produced the injury. The determination of the source and the probable voltage and amperage of the accidental contact is a problem for the electrical expert. Yet the inquiry as to what current is liable to produce a fatal result is important. Unfortunately the records available are quite meagre, and the various opinions as to what constitutes a dangerous voltage under different conditions are inconsistent.

This outline of a practical method of treating electrical injuries is submitted to emphasize their curability, not to enable the injured to be their own physician; the skill of the surgeon, and his aseptic dressings and redressings are essential to rapid recovery. It is well, however, to be prepared for emergencies by having on hand certain of the essential curative agents referred to in the present discussion in order that effective first aid may be administered. This is especially important for electrical operators in localities remote from any source of immediate medical assistance.—The Electric Journal.

KERR TURBINE CO., Wellsville, N. Y., announces the appointment of the following new agents: St. Louis, Walter L. Flower, 312 So. Eighth St., and New Orleans, C. E. Grevemberg, 1023 Maison Blanche Bldg.

AN AUTOMATIC FLOAT SWITCH

AN automatic float switch of new design has recently been placed upon the market by the Westinghouse Electric & Manufacturing Co. The new design embodies several features that recommend it highly for the control of motors driving pumps that empty into reservoirs, or drain pumps, sewers, etc. The operation of the switch is entirely automatic and the mechanism requires no attention beyond an occasional inspection and oiling. The switch is operated by a cylindrical steel float which plays between brass stops on a vertical rod, as shown in Fig. 1; the stops are adjusted to the upper and lower water levels.

When the float presses against either stop, a U-shaped tripping lever attached to the float-rod engages

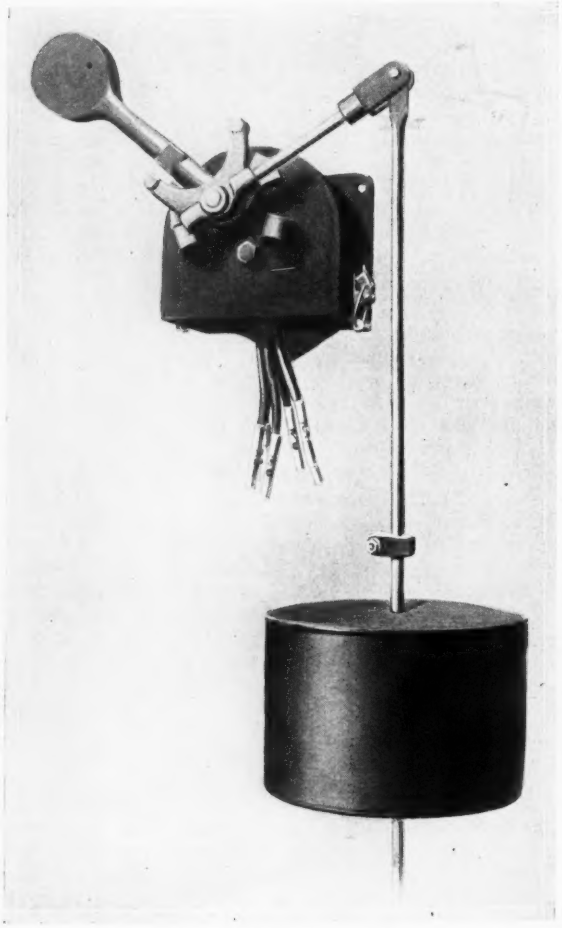


FIG. 1. WESTINGHOUSE AUTOMATIC FLOAT SWITCH

a pivoted weight arm and carries it upward and around past the vertical position. The weight arm then falls, engages an arm on the switch drum shaft, and snaps the switch open or closed, according to the direction in which the weight arm is thrown. A buffer receives the force of the weight arm's fall. When the float rod is attached to the tripping lever as shown in Fig. 1, the pump will be started when the float presses on the lower stop and hence is properly arranged for filling reservoirs. With the rod attached to the other side of the lever, the switch is adjusted for drainage purposes, as the motor will be started when the float presses against the upper stop. The switch is of the drum type with renewable contacts and fingers.

The float and float rod are heavily galvanized and are enameled and baked. This finish eventually prevents rust. The standard float rod permits maximum variations in level of 6 ft.

These switches are made in 2 styles, double pole for direct current and single-phase alternating-current motors, and 3-pole for polyphase motors.

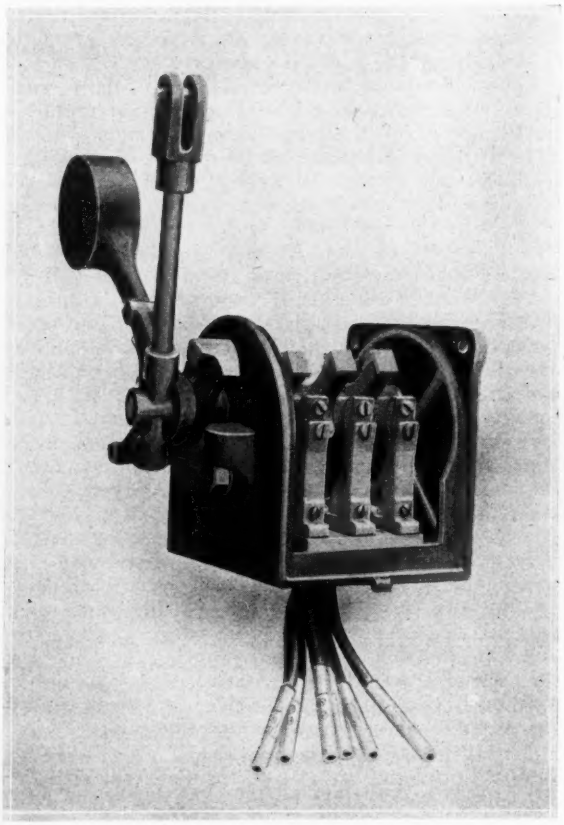


FIG. 2. INTERIOR OF FLOAT SWITCH SHOWING CONTACTS

The maximum capacity of these switches is 50 amperes at 550 volts. The motor is connected directly across the line and hence can be used only with motors that do not require reduced starting voltage.

WHO WAS CRAZY?

FOLLOWING is a report in the newspapers: "Locomotive No. 1339 of the Boston and Maine R. R., was in Lowell round house and had been in all night with banked fire. In the early morning she started out of her own accord, ran down the track, crashed into a big freighter, throwing her off the road, then suddenly reversed, run back into the roundhouse, crashing through the rear wall, and finally coming to a stop in a brook. When the engineer reached her, her throttle was closed.

Can any of the readers give a solution of this mystery? Why did she start, and what caused her to reverse, all with the throttle closed? The engineers in the roundhouse say she went crazy; so that engines as well as engineers must have souls. R. H.

ECONOMY MEANS the same to owner and operator.

SOME POINTS ON BUYING OIL OR GREASE

WHAT A BUYER SHOULD LOOK OUT FOR IN PLACING AN ORDER FOR LUBRICANTS

By Frederick E. Dobbs

IN the manufacture of lubricants, both oil and grease, it is somewhat difficult to turn out a uniform product, so that it is quite necessary, in buying these materials, to have very accurate and definite specifications, and in the case of the purchase of a high priced lubricating grease it is always well to have a sample submitted for approval before delivery.

If a buyer has at his disposal a laboratory, he should adopt certain standards for the different lubricating oils and greases which his firm uses, and hold each consignment up to those standards, by sampling the goods when they arrive and having them tested at once.

Some of the tests which can be used to find out whether a uniform product, fully up to standard, is being furnished, are as follows:

Lubricating Oils, Viscosity

AS the value of an oil for lubricating purposes depends largely upon its viscosity, we will endeavor to give a simple method of comparing the viscosity of one oil with another.

Fill a 10 cubic centimeter pipette with the oil from the new shipment and another like pipette with the oil from a previous shipment, fix them in a vertical position by means of 2 clamps, on a ring stand, and count the number of seconds occupied by each oil, in flowing from a mark on the upper stem of the pipettes to a mark on the lower stems. It is unnecessary that the oils to be tested be always at the same temperature.

Flash Point and Cold Test

THE flash point is the temperature at which the oil begins to give off sufficient gas to ignite if a spark is brought near the surface of the oil. In order that the results may be uniform, it is necessary to keep the following constant:

Quantity of oil used each time.

The distance the thermometer is immersed in the oil.

The number of degrees per minute the oil is heated.

The size of the spark used.

This cold test is to determine the temperature at which the oil freezes or solidifies.

Free Acid or Alkali

FREE mineral acid or alkali which can only occur through imperfect refining should not be permitted in any oil, owing to their corrosive action upon metallic surfaces. In order to find out whether an oil contains either of these, it is necessary to have the oil carefully analyzed by an experienced chemist.

The amount of free fatty or resin acids permissible in a lubricating oil depends largely upon the purpose for which it is used. A refined mineral oil should contain none whatever and when an animal or vegetable oil is used as a lubricant not more than 4 per cent of free fatty acid should be accepted. The less there is below this amount the better the oil.

Lubricating Greases

IN the purchase of lubricating greases it is necessary to secure a lubricant the consistency of which allows proper application to the parts of the machinery for which it is designed, and that the kind and proportion of the different ingredients of which it is composed, make it the most efficient lubricant for that particular bearing. Although in selecting lubricants the price is an important factor, there is no real economy in using cheap or unsuitable grease. Not only may the loss by friction be largely increased and the wear and tear of the bearings become very great, but the life of the parts be shortened by the use of an inferior lubricant.

After it has been determined what particular kind of lubricating grease is best adapted to the work in question, it would be possible to find out the following points about it, and adopt the results of these tests as a standard for this grease:

(a) The percentage of mineral oil contained in the grease; it is desirable to have as high a percentage of mineral oil in a lubricating grease as is possible.

(b) The percentage of free fatty acid in the grease; this quantity should be very small. The presence of more than 2 per cent causes the grease to oxidize and become gummy. (c) The percentage of free alkali left in the grease; in a properly manufactured grease there should be not more than a mere trace of free alkali. The presence of any of this material will cause small, hard lumps and grit to form in the grease and greatly impair its lubricating qualities. (d) The temperature at which the grease will melt or separate; the melting point of a grease should be carefully determined in order to see that the grease does not melt or separate below the temperature at which it is intended to be used. (e) The percentage of moisture in the grease; more than 2 per cent water is undesirable in most lubricating greases as the presence of water in larger quantities than this is very liable to make an inferior lubricant of the grease. (f) The consistency or body of the grease; this can be determined best by any simple method of measuring the resistance of the grease to pressure. It is an extremely important point to watch as the efficiency of a lubricant depends largely upon its consistency. In addition to all of these tests, it would be well to watch carefully the general appearance and action of the lubricants being used.

To prevent highly polished metal surfaces from rusting, take 1 oz. of pure beeswax and after cutting it up fine, place the pieces in a quart bottle and fill with naphtha or benzine. Cork tightly and after allowing it to stand for 24 hours or more, carefully draw off the clear solution into another bottle and it will then be ready for use. Take a small sponge and cover the article or surface you wish to protect as lightly as possible with the solution and then allow the parts coated to stand for 30 minutes or more so as to give time for the benzine to evaporate, after which polish with soft paper, clean waste or chamois skin.

According to the Mechanical World a cement which is effective for cementing rubber to iron is made as follows: Powdered shellac, one part; strong water of ammonia, ten parts. Put the shellac in the ammonia-water and set it away in a tightly closed jar for three or four weeks. In that time the mixture will become a perfectly liquid transparent mass, and is then ready for use. When applied it forms a firm bond.

CONVEYING AND ELEVATING MACHINERY FOR THE POWER HOUSE

FLIGHT CONVEYORS

By Reginald Trautschold

USE of belt conveyors for handling coal and ashes in the 2 power houses, described in November issue, enables the operations of conveying to be performed at a very low cost. In fact, under the conditions existing no other apparatus could be used with greater economy. It must be remembered though that in these large plants that necessitate the handling of much fuel and refuse, the question of net operating cost is of considerably greater importance than that of initial outlay for apparatus. There are, however, many plants in which the first cost of apparatus is an important consideration and, though the net operating cost must always be reckoned with, it may sometimes be forced to take second place by the prohibitive price of more efficient apparatus. In such a case, flight or scraper conveyors may be substituted with considerable saving in first cost and the operations of conveying still be performed economically.

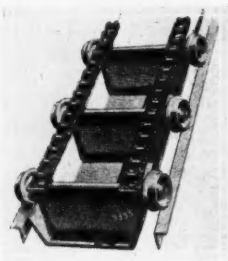


FIG. 1. SINGLE STRAND FLIGHT CONVEYOR WITH SLIDING SHOE FLIGHTS

FIG. 2. DOUBLE STRAND, ROLLER FLIGHT CONVEYOR

Flight conveyors also possess certain advantages over the more generally efficient belt conveyor. For example, they can be used to carry quenched ashes from the boiler room directly, no expensive discharging devices are required for unloading at any point, a greater inclination is possible when elevating and the capacity of a flight conveyor is greater than that of a belt conveyor of the same width, even at the slower speed at which it is operated. Flight conveyors, however, consume more power than do belt conveyors and their depreciation and deterioration (cost of maintenance) is more rapid. The breakage of coal in transit is more serious with a flight conveyor, but the breakage due to shock when unloading is somewhat less.

From this comparison it is seen that relative efficiencies of these 2 types of conveyors depend largely upon the consumption of power. In order to keep this expense at a minimum, flight conveyors are generally of one of 2 improved types: one in which the flights are supported on sliding wearing shoes and the other having the flights carried by rollers or wheels. These 2 refinements greatly reduce the consumption of power over that required for the old types in which the flights were allowed to scrape along the bottom of the trough, but as they vary considerably between themselves in their efficiency to cut down power consumption and as there is a corresponding difference in their net operating cost, the 2 types will be separated in the following discussion.

Capacity

THE normal cross-section area of the load carried by a flight conveyor usually approaches a rectangle in shape and the capacity of this type of conveyor is therefore great—see Table I, Data Sheets. This table gives the capacity of the common sizes of conveyors handling coal and ashes at advantageous speeds commonly used for conveying such materials. The capacity at any other speed varies, of course, directly.

A convenient approximate rule for ascertaining the capacity of flight conveyors is based on the area of the flights. A conveyor handling coal has an hourly capacity of about 1.25 tons for each square inch of flight area, flights spaced every foot, when running at 100 ft. a minute. The capacity is also inversely proportional to the spacing of the flights. When carrying ashes at 100 ft. a minute the relation existing is approximately 1⅛ tons capacity per hour, flights spaced every 12 in. These capacities and those given in Table I apply only to horizontal conveyors, as any inclination decreases the load that can be conveyed. A conveyor inclined 10 deg. to the horizontal is capable of carrying but 80 per cent of the capacity of a level conveyor, one inclined 20 deg. only about 67 per cent, while an inclination of 30 deg. cuts the carrying capacity to 50 per cent that of a similar horizontal conveyor.

In choosing the size of conveyor to be used the size of the coal to be carried must be taken into consideration. Run of mine coal, for instance, cannot be handled economically on a flight conveyor less than 18 in. wide and a larger conveyor is advisable. If the material to be conveyed should not run pretty uniformly as to size it is also well to use conveyors with 2 strands of chain, even when the conveyor is a narrow one. This question of single and double strand conveyors also affects the cost of operation and the burden to be carried and will therefore be referred to again.

Power

IT is in the consumption of power that the 2 types of flight conveyors, previously referred to, vary in economic value. A flight conveyor having flights of the roller type being capable of carrying one ton of coal or ashes a horizontal distance of over 7/32 mile in one hour for a horsepower, while the less efficient type, that with the flights carried on sliding wearing shoes, would carry the same load less than 1/5 mile on the same power.

This rating is equivalent to a capacity of about 11.5 tons conveyed a horizontal distance of 100 ft. per horsepower-hour for a conveyor with roller flights and 10.5 tons per hour on one horsepower by a similar conveyor with wearing shoe flights.

An inclined conveyor consumes additional power, equivalent to the work necessary to elevate the load, and the power necessary is further increased by the

requirement of a larger conveyor to elevate a given load than would be required to convey it horizontally. These relations are conveniently expressed in Formulas 1 and 2 by which the horsepower required for any flight conveyor may be calculated. The horsepower required as obtained by the use of these formulas is that actually needed for a well constructed flight conveyor and the factor of tonnage per hour must be corrected for loss in capacity due to any inclination of the conveyor. That is, a conveyor inclined 30 deg. to the horizontal would have a load factor of but one-half that given in Table I.

Roller flight conveyors.

$$\text{Hp.} = \frac{0.8665}{1000} + \frac{WH}{1000} \qquad \text{Formula 1}$$

Sliding shoe flight conveyors.

$$\text{Hp.} = \frac{0.9539}{1000} + \frac{WH}{1000} \qquad \text{Formula 2}$$

Initial Cost

TWO general types of flight conveyors, those with roller flights and those with flights equipped with wearing shoes, may have either a single strand of chain attached at the center of the flight (upper edge) or 2 strands, one fastened to each side of the flight. The single chain is good practice for narrow conveyors but those more than 15 in. wide should be furnished with 2 strands of chain. The double chain reduces depreciation and for wide conveyors is necessary owing to the impossibility of loading the conveyor uniformly from side to side. Two strands also permit the use of cheaper chain and the additional cost of such construction is not much more than that for the extra sprockets that are, of course, necessary.

Table—Approximate Cost of Flight Conveyors

Type of Conveyor	Handling	Speed ft. per minute	Cost, Dollars
R′	Fine coal	200	0.018653WL + 0.275W
S′	Fine coal	200	0.011945WL + 0.275W
R″	Fine coal	200	0.018922WL + 0.275W
S″	Fine coal	200	0.012215WL + 0.275W
R′	Lump coal	125	0.028844WL + 0.440W
S′	Lump coal	125	0.019112WL + 0.440W
R″	Lump coal	125	0.031076WL + 0.440W
S″	Lump coal	125	0.019544WL + 0.440W
R′	Ashes	150	0.027358WL + 0.404W
S′	Ashes	150	0.017519WL + 0.404W
R″	Ashes	150	0.027752WL + 0.404W
S″	Ashes	150	0.017915WL + 0.404W

W signifies wt. of coal, tons per hr; L, length of conveyor in ft.

R′ signifies roller flights—single strand conveyor.

S′ signifies shoe flights—single strand conveyor.

R″ signifies roller flights—double strand conveyor.

S″ signifies shoe flights—double strand conveyor.

The accompanying table gives the approximate cost of equipment necessary for a high grade flight conveyor of the various types, expressed in terms of capacity of conveyor handling either coal or ashes at the speeds given in Table I. These costs make a due allowance for an average number of plain slide gates in the bottom of the trough through which to discharge the load, but no provision is made for the power unit as this depends entirely upon the equipment of the power house and correspondingly upon the kind of power most readily obtainable.

Conveyors that are run at any other speed than those given in Table I will have, of course, a different capacity and their cost as given here will increase or decrease as the capacity varies. For instance, the cost of a flight conveyor carrying fine coal at a speed of 100 ft. a minute would be twice as great per ton handled as one operating at 200 ft. a minute.

Operating Cost

ECONOMY of the roller type of conveyor is again emphasized when the net operating cost is considered. The saving in power, although somewhat offset by the increase in initial cost, is an important factor in reducing the net expense of operation. The lower depreciation and maintenance charges of this more efficient flight conveyor construction also minimize this expense.

Decrease in maintenance cost due to using 2 strands of chain, in either type of conveyor, is very nearly balanced by the increase in burden due to greater initial cost and corresponding increases in the expense for taxes and insurance. That is, the net operating cost for a single strand and a double strand flight conveyor is the same, for all practical purposes, and furthermore, the construction of chain is governed by mechanical requirements.

Comparing the 2 types of flight conveyors, first, for cost of operation: The cost for power is greater for conveyors with sliding wearing shoes, as is also the expense of supplies necessary to keep the system in good running order, but the cost of labor is about the same in either type. The cost of maintenance again favors the roller flight conveyor as the charge for depreciation is not as great for this type of construction, notwithstanding the greater initial cost. The burden, depending as it does upon the value of the outfit, is greater in the case of conveyors with roller flights. The sum total of all these expenses, the net operating cost, is slightly more for conveyors of the sliding shoe type than for the more efficient construction.

Table II in the Data Sheets gives this net operating cost, by the 2 varieties of flight conveyors, in terms of the cost of horsepower, also on the assumption that a horsepower costs $60 a year, or 2 cents an hour. This table applies equally well to conveyors handling ashes and those carrying coal as, the greater the fixed expense, due to greater initial cost per ton for conveyors handling ashes, is about offset by the slightly greater depreciation in the case of conveyors used for carrying coal.

INVESTIGATION HAS SHOWN that for use in ball bearings, there must be a lubricant which first, protects the working surfaces, and second, lubricates. For durability it is important that there shall be no scratches or abrasion of the polished surfaces of balls and races, and rust or corrosion produces a series of craters and ridges which cause the lead to be concentrated on a few points that are soon crushed. Protection is therefore of first importance, but lubrication is also essential, since balls must rub slightly against the separator and also have slight creep on the race.

To serve these requirements, a lubricant must be neutral chemically, that is, have neither acid nor alkali present, and must be free from solid substances of a mineral nature or such as a gummy filler; the grease must also be permanent because it may stay in a bearing 6 months or a year without renewing.

To fulfill these requirements an artificial or mineral grease, free from foreign ingredients is theoretically the best lubricant for ball bearings for speeds up to 200 r.p.m.; but the grease must be carefully made to avoid the presence of any acid or alkali and of consistency which will avoid thickening or drying. A very pure mineral grease is therefore the best.

MAKING PIPE BENDS AND FITTINGS

METHODS FOR HANDLING BIG WORK IN A BIG WAY

RADIATING from Pittsburgh in all directions are busy suburbs, the homes of great industries which contribute to the wealth of the "Iron City." Up the valleys of the Allegheny, Monongahela and the Ohio Rivers are dotted world renowned plants, each a center of activity for a crowd of humanity, each contributing its share, large or small, to the welfare of the world.

Among the latest additions on the Allegheny River is the home of the Best Mfg. Co., at Oakmont, with its special station called Edgewater. While the location was chosen with good commercial sense for facility of production and shipment, yet as one approaches the works he feels that it might well have been chosen for the beauty of the surroundings and the attractiveness of the country. From the station a smooth and scrupulously clean driveway leads to the gate where the attentive watchman keeps guard to serve the convenience of those having business at the plant and to prevent the intrusion of those having no business.

The sight is a pleasant one; rising above the works, a guardian of its safety in case of fire and a caretaker of the health and needs of the workers, is a water tank carrying an illuminated sign, "The Best Manufacturing Co."

Shading the entrance is a grand tree with wide spreading branches beneath which one pauses for a chat with the pleasant guardian of the gate before entering.

The property owned by the company is shown enclosed by the light line, Fig. 1, and extends from the right of way of the Pennsylvania Railroad to the banks of the Allegheny River; at the present time the part enclosed by the heavy lines, which represent the fence surrounding the plant is filled in and in use. Materials come in and finished products go out over the branch to the railroad, the terminals entering the pipe yard, the foundry stock yard, the end of the machine shop and the end of the foundry. From the foundry stock yard the raw material such as coke, pig iron, limestone and so forth pass to the charging elevator for the cupolas which are located about the center of the foundry; lumber, after storage in the shed provided for that purpose until it is partially seasoned, is passed to the gallery in the machine shop, where near the pattern room is a drying kiln for completing the process.

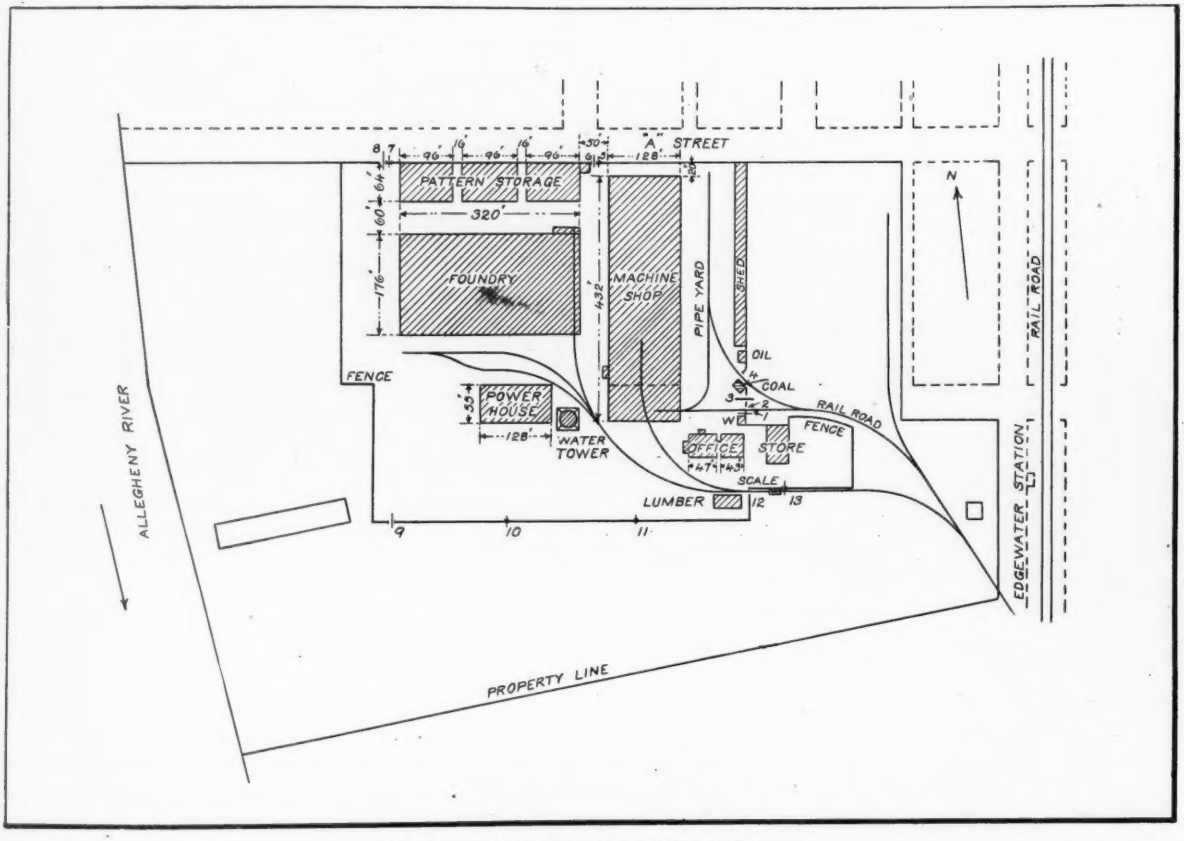


FIG. 1. PLAN OF WORKS OF BEST MFG. CO.

Besides the main switch tracks, an industrial railway is provided for the handling of heavy material on truck cars, and this supplemented by plentiful provision of cranes avoids any possible need for heavy lifting in the handling of big pieces which constitute a large part of the Best output.

As we step from the office there fronts us the pipe yard where in orderly rows are laid at call large pipe and small pipe, in long lengths and medium lengths, and at one side in a shed are stored the short lengths and pieces which may be demanded for special work. Lengths up to 40 ft. are obtainable in a single piece and are now used in the making of bends in sizes of 12 in. diameter and less. The ability to get these lengths bent into any required form and with nozzles attached at any point desired gives great convenience and simplicity in the arrangement of difficult pipe lines as well as avoiding the numerous chances for joint trouble which would come from the making up of many small lengths of pipe with tee connections; and also in the making of long expansion bends does away with the location of joints where the come and go of the expansion would be likely to cause leakage trouble.

On leaving the train, and growing louder on approach to the plant, the clear ring of rapid hammers has been telling of clean solid metal in the working, and of honest effort, effectively applied. Now, as we turn to the left and enter the bending section of the machine shop, we discover the cause of this merry clatter. For shrunk and peened joints, it is necessary, after the red hot flanges have been carefully set over the end of the pipe and located true, that the end of the pipe be swaged out over the corner of the flange and also near the end be set into a groove turned in the flange. This is, of necessity, hand work, and it is the rat-a-tat of the hammers forcing the metal home to its seat that we have been hearing.

While this is attractive, it is simple, earnest work that can be easily comprehended, and attention is

FIG. 2. LOOKING DOWN THE PIPE YARD

soon turned to the other side of the bending room where the roar of the furnaces, like a tempest at fury tells of the loosed energy, and we are drawn there to learn the cause of activity. It is there that we find one of the most interesting features in the works, the process by which a straight and well conducted piece of piping is lead to depart from its ways and to tread all sorts of devious paths. And all the uproar is about this one thing, to heat and play upon the iron natures of these pipes so that they shall yield readily to the coaxing of the master workman and shape their courses according to his will and the needs of those whom he serves.

The bend must be accurate to save the effort and patience of those who will use it; it must be graceful that it may not offend the eye or bring undue strain upon other parts of the system; it must be flawless so that no weak point may develop where a leak or rupture may get a start. And to secure these results requires the knowledge gleaned from experience, the care which comes of love of work well done, and the thoughtful watchfulness born of difficulties encountered and overcome.

First in the bending comes the filling with sand from an overhead hopper by gravity, and then the hammering of plugs into the end, so that the pipe may have a chance to yield and yet may hold its true round form during the time of bending. Then to the furnaces with sectional tops and heated in sections by natural gas and air blast, with water cooled pipes along the edges to prevent the burning down of the brick walls, and in this intensified Turkish bath the pipe remains until at the point where the bend is to come every fibre is aglow with heat, and blushing red.

As the experienced eye of the foreman finds that the right condition has been reached, up sweeps the lid of the furnace and the pipe is slid to the bending table, where with stakes and tackle, with bar and templet,

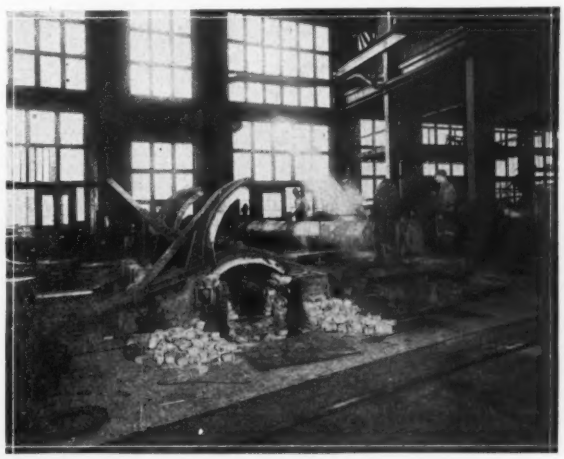


FIG. 3. PIPE BENDING TABLES

with fitting and trying to exactness, here a little and there a little, with a cooling stream of water at one point and a tug at one end or the other, the great columns are made to take on shapes at will of angles, bends or offsets, until as the mass lies ready for shipment it looks like a heap of writhing serpents interlocked into an almost inextricable tangle.

To show the accuracy with which the work is done, a piece on the floor at the time of the visit was 12-in. pipe, having one end 4 ft. 4 in., the other end 12 ft. 3 13/16 in. to the center of the bend, and the bend to be made at an angle of 39 deg. and 10 minutes; and another great piece of pipe 24 in. in diameter and some 30 ft. long was formed with a double offset. Various of the views herewith show somewhat of the bending that is done here.

Near the end of the bending floor is located a smaller furnace where the Van Stone joints are made. In this Van Stoning process, the ends of the tube, after heating until pliable as man to the will of woman, are placed in a clamp, with the end projecting to gage; then by the application of a heavy pressure roll forced by a spring remorseless as Fate, the end is put over like the brim of a hat and moulded to a perfect fit against the flange. Thus the ends of the 2 pipes at a joint are brought together with packing between, leaving no possible chance for the escape of steam around the flange. The precision of setting, gripping, rolling,

releasing are like the evolutions of a crack gun crew on a man-o'-war.

After the Van Stoning, the pipes are put in a lathe and the outer ends faced off to give a true surface for the packing, and in the rare cases where it is necessary to patch the end of the pipe with the oxy-acetylene blow torch, on account of the slight opening of the lap joint where the turning back takes place, the Van Stoned end is back-faced where it comes against the face of the flange.

This oxy-acetylene process is used also for the welding of pipes together, end to end, and for attaching

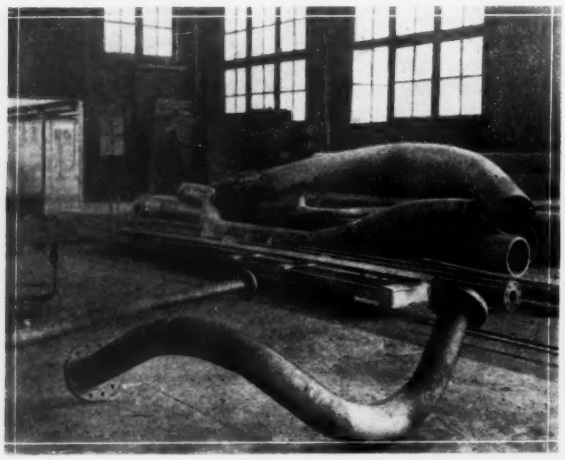


FIG. 4. SOME OF THE PIPE BENDS DURING CONSTRUCTION

welded nozzles to headers. It gives a weld as complete as can be made by the blacksmith's forge, and makes it possible to weld 2 pieces of any shape. The hole where the nozzle is to connect is drilled out and the end of the nozzle is then deftly fitted to conform to the surface of the header. By the blow torch the 2 surfaces are then heated to a welding heat, and the joint is filled with a fillet of iron melted into place by the flame of the torch. In this way any number of nozzles can be put on at any angle, doing away with all tees and flange joints in making up the header.

In the lathe which faces off the Van Stone joints, pipe can be handled up to 38 ft. in length, so that it becomes possible to make a length of pipe or a header in one piece from a 40-ft. length of pipe up to 12 in. in diameter. Where a long section of larger diameter is required, 2 sections are welded together, end to end.

As we turn from watching this process, we find behind us a carload of the Best products finished for shipment. In this are included several big cast-iron fittings intended for exhaust lines, large valves, small valves, fittings of small and medium sizes, and a number of the pipe bends already mentioned. We wanted to know further about the construction of these other products, and it seems wisest to follow the course of a shop order so that we may see just how each operation is taken care of.

We therefore step into one of the 4 hydraulic plunger elevators which give convenient access to the gallery and are carried to the pattern shop where the preparation is made for carrying out the shop orders for valves or fittings. Many of the large fittings are special, and but one casting, or at most two or three, are made from the pattern, so that it is not advisable to put a large amount of labor or material into the pattern. Under these conditions, for large fittings a skeleton pattern is used, in which the flanges are made of the correct size and thickness and a dummy core box consisting of the two end forms of the core held in the proper relative position is made as template to serve as a form into which the core can be built in the core room of the foundry.

FIG. 6. A CARLOAD OF BEST BENDS AND FITTINGS

FIG. 5. A BIG HEADER WITH WELDED NOZZLES AND VAN STONE FLANGES

In the case of the smaller patterns, a rough frame is constructed and covered with sheet iron to give a pattern of the form desired. These hollow sheet iron patterns serve quite as well as a solid wooden form where but few moulds are to be made, and they are much more easily changed to fit the different orders than a solid wooden pattern.

A skeleton pattern and skeleton core box for big elbows are shown in the illustrations, and also several cores are seen in some of the foundry views.

At first thought it seems like a peculiar proposition to start in to make a big cast-iron elbow or tee with

nothing but a couple of flanges and about ten bushels of air, but after seeing the process as carried on by the workmen in the Best foundry, it becomes quite evident that this is the only logical way to handle the proposition.

The pattern shop extends across the north end of the gallery and along the two sides about half the length of the shop. On each side of the side galleries the machinery is installed in duplicate so that the workmen do not have to go far from any bench position that they may have to get to a tool that may be needed, for sawing, planing or other operations.

In the east gallery there is also a dry kiln for seasoning the lumber after it has had a session in the out-door seasoning shed. Lumber is here placed by the carload, and a little steam is kept playing into the kiln for a time, so that as the moisture drys out surface cracks may not develop. This steam is gradually turned off as the lumber becomes dried on the inside, and finally the material is kept at a high heat in a perfectly dry atmosphere for a considerable time, the whole process requiring some six weeks. Through openings at the top and sides of the kiln, a strong current of air is constantly circulating to carry off the moisture as it leaves the lumber. After being thoroughly seasoned and dried, the lumber is stored on racks at the north end of the pattern shop awaiting use by the workmen.

Lighting, which below stairs is largely by flaming arc lamps and by incandescent lamps for the special tools, is here accomplished by the use of Nernst lamps hung overhead, and giving sufficient general illumination for all the light necessary without special lamps for benches or tools.

In the west gallery are found brass working lathes for making the unions and small valves, and for making the brass seats and valve disk rings for the larger valves.

In the section devoted to small valves and brass workings, the most notable feature is the universal union with spherical end fitting a spherical socket. The socket is worked out by means of a special reamer but the surface of the ball for the union is worked out by means of a circular slide rest which swings to turn the ball to form. After the turning it is worked down with emery paper to a smooth polished surface.

As is usual in such work, the small valve construction is done largely on turret lathes by the use of special tools.

An interesting process is the making of brass seat rings for gate valves from a single brass tube, by a continuous process in which the tube revolves without stopping, while by means of turret head tools and cutters the seat rings are turned, threaded and cut off as fast as the cutting speed of brass will permit.

(To be continued)

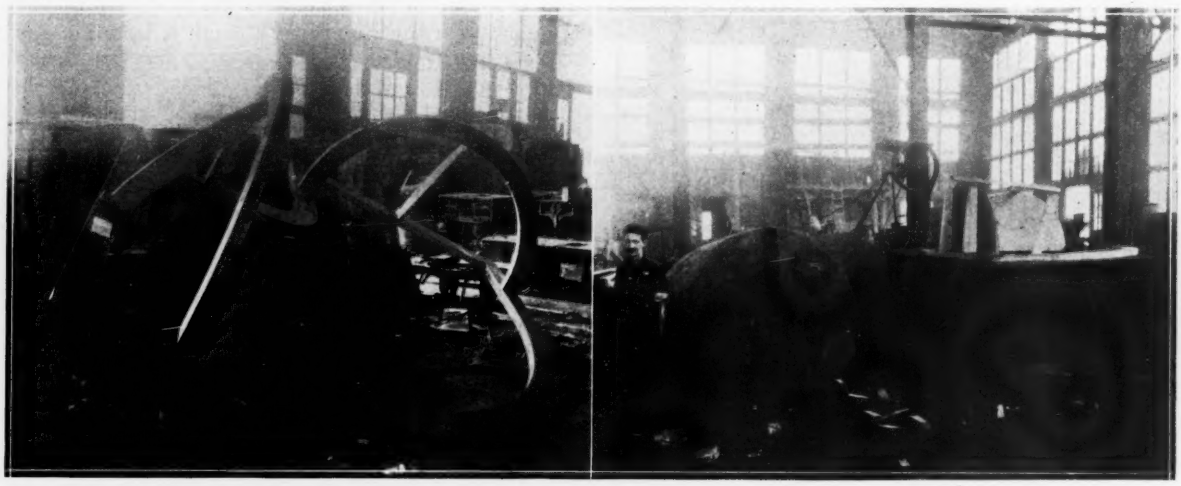


FIG. 7. SKELETON PATTERN, CORE BOX AND CORE USED IN MAKING A LARGE ELBOW

MELTING POINT OF TIN FOR FUSIBLE PLUGS

PURE tin makes the best filling for the fusible plugs of steam boilers, alloys being objectionable because those that have been tried for the purpose appear to undergo a gradual change when exposed continuously to heat, so that their melting points do not remain constant. Four close determinations of the melting point of tin have been made, giving an average of 449.2 deg. F., which is likely to be within a few tenths of a degree of the true melting point of pure tin.

According to the formula given by Marks, in the Journal of the American Society of Mechanical Engineers, the pressure of saturated steam at 449.2 deg. F. is 378.0 lb. per sq. in. above a vacuum; so that it will be seen that a tin-filled plug will not melt out from the natural heat of the steam until the pressure of the steam becomes 363.3 lb. per sq. in. greater than the ordinary pressure of the atmosphere. The tin might perhaps soften at a somewhat lower temperature, sufficiently to blow out, but between the highest pressure now used in the generation of power, and the pressure at which pure tin will melt from the heat of steam alone, there is evidently a margin wide enough to take care of any contingency of this kind, without the slightest uncertainty.—The Locomotive.

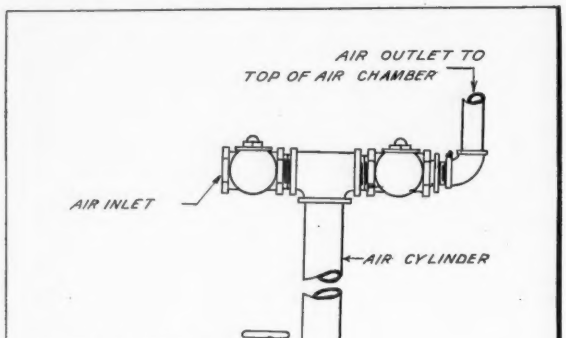
IT IS BETTER to make a life than to make a living,—though the man who makes a life usually makes a living. This greater business of life includes thoughts good and bad; associations, habits and everything that goes to the making of character. A man of character doesn't have to plead to be allowed to prove what he can do. All that's behind him is speaking for him through his face, his manner, his voice, his eyes and his general attitude. They back up his claim that he can deliver the goods.—Leigh M. Hodges.

COMPARATIVE EFFECT OF AIR VESSELS ON DEEP-WELL PUMPS

By John Creen

SOME time ago I was called upon to investigate some trouble with a deep-well pumping engine, which the engineer in charge could not locate or remedy. The total lift of the pump was 200 ft., discharging through 1100 ft. of 8-in. iron pipe into a reservoir on the top of a hill; at a considerable distance from the pump. Bolted on to the discharge main was a length of 8-in. pipe 8 ft. long, which was intended to act as an air vessel.

The trouble complained of was, that a very heavy knock was felt throughout the whole system, that there was an intermittent discharge of water from the pump, and each successive stroke was equivalent to a blow which was not localized but distributed through the whole system; the final reaction, however, came upon the pump, and as the pressure in this case is a fairly heavy one (being not less than 120 lb. per sq.



PIPING ARRANGEMENT FOR SUPPLYING AIR TO AIR CHAMBER

in., including water friction in pipes), leaky joints, broken castings and inordinate wear and tear were the inevitable result.

After seeing the pump in operation for a short period, it at once became apparent to me that the 8-ft. length of 8-in. pipe used as an air vessel was worse than useless, and totally inadequate for the work it was called upon to perform. The cubic capacity of an air chamber should not be less than 3 times that of the pump's displacement; that is per single stroke, and this is for moderate pressure and speed only, such as boiler feeding, tank service, etc. If the pressure is 100 lb. per square inch and upwards, combined with a rapid piston movement, then the air chamber should not be less than 6 times the displacement of a single stroke of the pump piston or plunger. For double-acting duplex pumps, the cubic capacity of the air chamber need not be more than ⅔ of that given above.

The form of an air chamber admits of considerable latitude in design; the diameter and height being governed somewhat by its intended location, but in every case care should be taken to give the proper cubic capacity. The diameter of the neck of an air chamber should be no larger than that necessary to give stability to it and insure proper strength of connection to the flange by which it is bolted to the pump or pipe. The larger the neck the greater will be the disturbance of the water level in the air chamber, and the less efficient it will be in correcting the inequalities of flow and cushioning the pump against shock. The diameter of the neck of an air chamber generally approximates from one-third to one-fourth that of the air chamber itself with, of course, its corresponding diameter of flange.

It is generally known that water contains air in suspension or solution, and in imperfectly designed hydraulic machinery is likely to make trouble if there be air pockets or cavities in which it may collect.

Having this fact in mind one would naturally conclude that an air chamber would always have its proper supply of air; that there would be no decrease in quantity at any time, even though it were not augmented by the liberation of air from the water when passing through the pump; but the reverse of this is true, and it is a common experience that air in large air chambers almost wholly disappears, passing off, probably, with the water by absorption when under compression. For this reason the air chamber should always be fitted with a gage glass, so that the amount of air in it may be seen at all times.

The rough sketch shows the construction of an automatic air pump, for supplying the air chamber with air; it is exceedingly simple, and can be constructed and fitted to any existing pumps at a small expense, most engineers having the necessary valves, pipe and fittings on hand. The writer made and used one for quite a number of years and it did its work in a very satisfactory manner.

It consists of a piece of, say, 2½-inch wrought-iron pipe about 30 in. long, which we may call the air cylinder, on the top of which is screwed a 2½-in tee, one end having a 1¼-in. check valve opening inward, and on the other end of the tee a ¾-in. check valve opening outward; a pipe from this small check valve leads to the air chamber. On the bottom of this 2½-in. pipe, which we have called the air cylinder, is screwed a cap, from which a 1-in. pipe, which we may name the supply pipe, leads to the water cylinder head as shown; between the 2 is inserted a gate valve or cock, which completes the whole apparatus, and which is suitable for supplying the air chamber of a pump delivering from 750,000 to 1,500,000 gal. in 24 hr. To start this air pump it is necessary that the pump to which it is attached shall be in operation; first open the gate valve in the supply pipe leading from the water cylinder head to the air cylinder to charge the latter with water; then partially close this valve until the check valves begin to work; this is easily determined by the click of the valves on the seating.

The operation of this apparatus may be briefly described: Once the air cylinder is full of water, any lowering of the water will be the cause of a vacuum above its level; the air entering through the inlet check valve immediately fills this space above the water at atmospheric pressure. The distance to which this water shall be lowered can be controlled by the gate-valve in the supply pipe under the air cylinder; the water is lowered in the air cylinder by reason of its open connection with the water cylinder of the pump,

for each time the water piston draws its water the same vacuum is had in the air cylinder, as that in the suction chamber of the pump. The air cylinder being of so much larger area than the supply pipe leading to the water cylinder, there is not sufficient time for the air cylinder to completely empty itself before the change in the direction of motion of the water piston, which at once changes the direction of the flow in the supply pipe, arresting the downward movement of water in the air cylinder, forcing it upwards and filling the air cylinder completely with water from the water cylinder of the pump, thus driving the contained air in the air cylinder through the delivery check valve into the upper portion of the air chamber.

It will be seen that this operation is precisely similar to that of a reciprocating air pump, the rise and fall of the water being exactly similar in effect to that of a reciprocating piston. There will be a greater velocity of water upwards in the air cylinder than in its downward movement, because the latter movement will have a velocity due only to the pressure of the atmosphere, whereas the upward movement has a velocity due to the pressure given it by the action of the piston of the main pump. There will always be a little water carried over with the air into the top of the air chamber; this, however, serves a useful purpose, for by it the clearance in the air cylinder is entirely eliminated.

There is no uniformity of opinion among engineers or mine managers in general as to the utility of air chambers on mining and deep-well pumps, the drift of opinion being rather against them, mainly because they soon fill with water, and therefore become useless for the purpose intended.

Owing to the indifference regarding the important detail of a pump, there has rarely been, until perhaps within the last few years, any device by which the pressure, and especially the volume of air is maintained in the air chamber, thereby failing to secure the benefits of an elastic cushion in the delivery chamber of the pump and piping system.

In the case of a single mine or deep-well pump, a large air chamber is of great advantage, and under no circumstances should it be omitted.

After pointing out these facts to the engineer of the plant under review, I suggested substituting a suitable air chamber of sufficient cubic capacity for the 8-ft. length of 8-in. iron pipe, the new air vessel to have a contracted neck not less than ⅓ the diameter of the chamber itself, and to be fitted with the automatic air pumping device.

This was done, and after its installation all the trouble complained of disappeared and the plant has since been operating to the entire satisfaction of all concerned.

PACKING LEATHERS

By F. W. Bentley, Jr.

EVER since compressed air has been used in connection with brakes, hoists, and other labor saving devices that afford quick and powerful lifts or pulls, leather has been used almost exclusively to secure a perfectly air tight piston. In addition to the fact that leather is about the cheapest material that can be used for this purpose, there yet remains to be discovered anything that can retain the elusive compressed air as well within the cylinder.

Notwithstanding the fact that a new packing leather will do its duty after a fashion, no matter how negligently it may have been inserted, there are a few points about the correct manner in which it should be put in the cylinder that, if heeded, will tend not only to produce a more powerful hoist or brake, but to prolong the life of the leather as well.

Packing leather for any style of cylinder whatsoever, should be inserted so that the rough or untreated side of the leather will press the walls of the cylinder. It can readily be seen that this side is softer and more pliable, enabling it far more easily to absorb and distribute the lubricant put within the cylinder and thus prevent the excessive wear of the leather.

FIG. 1. METHOD OF SCARFING LEATHER PACKING

A point that greatly increases the efficiency of the leather, but in the majority of cases is either unknown, neglected, or forgotten is the beveling of the outer circumference on the side not touching the cylinder. The cutting of a packing leather in this manner is a process more commonly known as scarfing, and should leave the

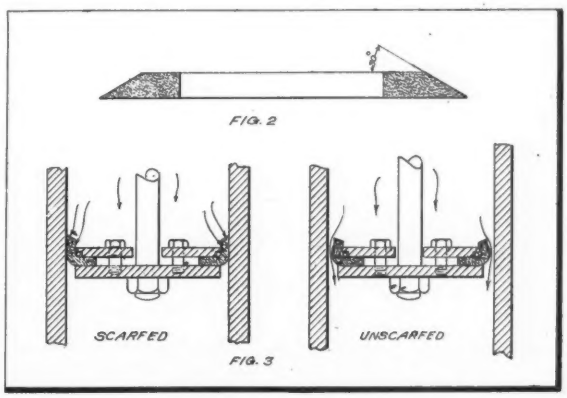


FIG. 2. CROSS SECTION OF LEATHER PACKING PROPERLY SCARFED

FIG. 3. ACTION OF AIR ON SCARFED AND UNSCARFED PACKING

outer rim of the leather with a knife edge. It should be scarfed to an angle of about 30 deg., and leave the leather as shown in Fig. 2.

A leather can be easily and quickly scarfed if it is held flat upon and flush with the edge of a planer bed or some other metal surface. The edge of the bed will hold the angle and guide the cut of the knife, as the leather is slowly turned during the cut. Figure 1

will make this clear. The reason for increased efficiency of a leather so treated is not hard to understand. The sudden inrush of air before a lift can easily force this thin edge tightly to the walls of the cylinder, making the piston air tight and allowing no possibility of a turning of the leather. The disadvantage of inserting an unscarfed leather lies in the fact that, to a certain extent, the leather will wrinkle and not touch the cylinder, and as the heavy thick edge is not so easily forced by the air to the cylinder wall, the leather is liable to allow air to escape, notwithsanding the presence of the expander ring. Figure 3 will show the action of the air upon scarfed and unscarfed leathers.

Many leather troubles are also due to faulty expander rings. There is perhaps nothing about a hoist that is given as little consideration as the expander ring, for instead of being of a circular form so as to force the leather evenly against the inner circumference of the cylinder, the ring, in many cases, approaches more of an oval shaped arrangement than anything else. In this case the only points at which the leather is forced against the inside of the cylinder barrel are at its belly or the

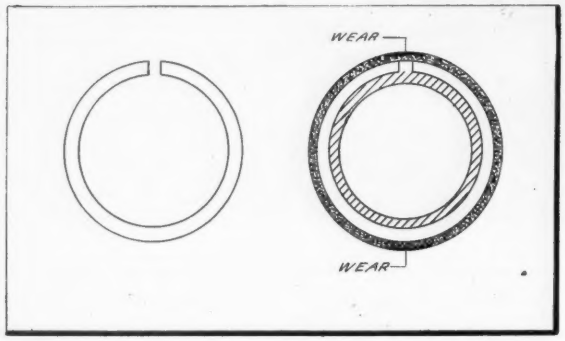


FIG. 4. FAULTY EXPANDER RING AND POINTS OF EXCESSIVE WEAR

point opposite the cut, and the place where the ring ends meet at the split. Such a ring produces an undesirable effect upon the leather, which as a result is severely worn in 2 places. At the same time the leather is not so closely touching other sections of the cylinder wall, and in this case even a scarfed leather is apt to allow the escape of air. Fig. 4 shows a ring in this

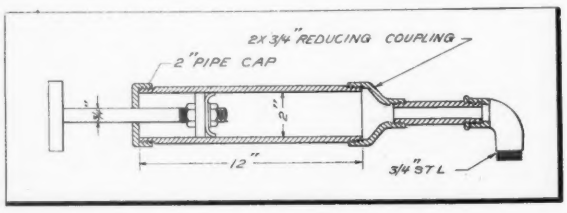


FIG. 5. DETAILS OF GREASE FEEDER

condition, and the effect it has on the leather. An expander ring should be perfectly round in shape when sprung within the leather, as it then forces every part of the leather evenly to the cylinder sides.

In conclusion the important question of lubrication should by no means be omitted. A packing leather needs plenty of lubrication for 2 reasons: first, that the leather may not wear out so quickly; and second, that it must be kept soft and pliable in order that it can adhere closely to the cylinder sides during a lift. A thin light oil is good enough for the time, but it is soon either carried out with the exhausts of air, or oozes past the leather when the hoist is not in use.

The only lubricant that possesses the necessary lasting qualities and other requirements, is a moderately heavy grease. The air cannot take this with it as it leaves the cylinder, and it also sticks well to the leather and the walls of the cylinder.

The task of getting even a heavy grease into a cylinder over the leather is an easy one, when forced in by the "grease gun" the details of which are shown in Fig. 5. This device is made almost entirely out of

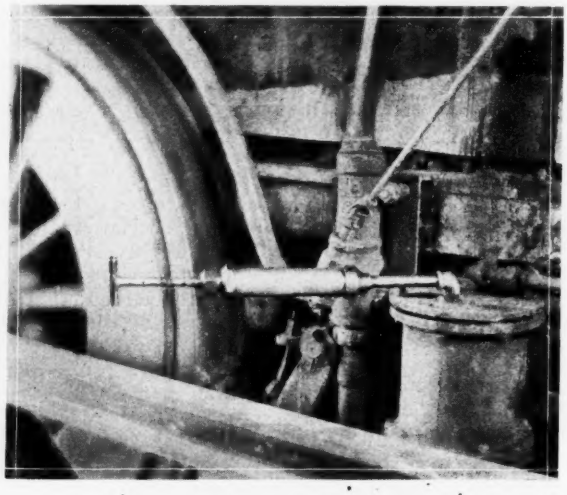


FIG. 6. USING THE GREASE FEEDER

old pipe fittings, and with suitable reducing bushings on the nozzle nipple, it will fit the oil hole in a cylinder head that is fitted with any sized pipe plug. Figure 6 shows this feeder as it is used for oiling the leathers in the driver brake cylinders of a locomotive. With a number of hoists that from time to time need attention this device will soon repay the small output of time and expense in making it.

THE AIR LIFT

By S. L. Hills

THERE seems to be no one branch of engineering upon which operating and consulting engineers are so uncertain as the pumping of water by the air lift, and in many instances no method of pumping which is so greatly condemned by both engineers and owners.

Nearly all the data available upon the subject is that which has been tabulated by two, or at most three, of the air compressor manufacturers, and to a great extent is kept secret by them for the use of their own engineers. It has been gathered from careful tests of hundreds of installations made by them and their engineers at a considerable expense, and it is only natural that they should not give it out broadcast but should keep it for their own information. They are always willing to make estimates upon any particular well if the prospective customer will fill out the question blank which they will gladly furnish.

The writer has been connected with one of these companies for several years and has found that the most important question of all is not answered in over 40 per cent of the blanks, and when answered quite often the word "Estimated" appears. The question to which I refer is: "Where does the water stand when pumping the required amount of water?"

For instance, if one has a well which is, say, 500 ft. deep, with the water standing in it at 45 ft., from surface when not pumping (often referred to as the static head), in filling out the question sheet it is stated that when pumping the required amount of water the level in well will be 125 ft. from the surface (estimated), or, in other words, the well drafts off 80 ft.

The compressor builder, upon this information, goes ahead and figures out the size of compressor required and the proper size and amount of air and water pipe which should be placed in the well. He puts in a bid on the proper size of compressor, gets the order and furnishes a sketch showing the proper size and length of pipes. The customer goes ahead and pipes the well and erects his compressor and starts up and turns the air on his well.

If a reliable and experienced company has furnished the compressor and sketch he gets results if the water drafts off to 125 ft., but if it only drops off to 100 ft. he has not the proper size or length of pipes in his well; likewise if it drops off to 135 ft. his well is not properly piped. He then puts up a great tale of woe to the compressor manufacturer and states that they have not fulfilled the guarantee, when the truth of the matter is the conditions are changed from those for which the piping was designed and for which the compressor was sold.

If an accurate gage is used and well has been piped according to instructions, it is only necessary for the customer to send the following information to the compressor builder and his engineers can tell in a few minutes whether they are at fault or the well. The information required is as follows:

1st. Measured distance to water in well before pumping.
2nd. Maximum starting air pressure.
3rd. Air pressure when pumping.
4th. Gallons being pumped per minute.
5th. Speed of compressor when pumping.

Gage must be placed upon air pipe as near the well as possible.

With this information the manufacturer will be able to know whether well was piped according to instructions and if well conditions are or are not as called for in contract.

The purchaser, rather than repipe the well in a proper manner for conditions as found by this test, is often, too often in fact, willing to let it remain as it is and go on pumping in an inefficient manner. Result: Both he and his engineer condemn the air lift. Then when a neighbor decides to put down a well they strongly advise against air lift pumping, which they have not given a fair chance to make good. But in such cases it is found, in fully 75 per cent of the installations made, that when an actual working test is made the well conditions are far from those for which the well has been piped.

It has generally been considered that there must be a submergence of 60 per cent for successful pumping, but the percentage of submergence for the best economy varies from 65 per cent maximum to 40 per cent minimum, all varying and depending upon the well conditions, the amount of water to be pumped per square inch of flow area varying from 18.5 gal. maximum to 3 gal. minimum. Likewise, the working pressure will vary from 200 lb. maximum to 15 lb. minimum.

Oftentimes in very deep wells the water will stand near the surface when the well is not being pumped, yet when pumping it will fall as much as 300 ft. This would mean that a compressor designed for a great deal higher pressure than the actual operating or working pressure would have to be purchased, owing to the excessive starting pressure. This has been obviated by the application of supplementary lifts for pumping off this excessive head, often 2 and sometimes 3 having to be installed in the same well, although their application should not be attempted excepting upon the advice of some experienced air lift engineer. Also, care should be used in the selection of a compressor suitable for the existing conditions.

If the requirements are for over 200 cu. ft. of free air a minute and for a working pressure of over 75 lb., a 2-stage compressor should be purchased. If a steam driven compressor is used it will only be necessary to equip it with a speed governor, unless air is to be used for other purposes. In this case a speed and pressure governor should be employed. If a belt driven compressor is used, it will be a useless expense to equip it with any kind of a regulator if it is to be used for pumping exclusively.

In cities like Memphis, where there are probably 100 wells being pumped by the air lift, the pumping conditions have been so well established that there is no chance of failure in getting the piping properly proportioned the first time it is installed.

To be sure, the air lift is not the most efficient method in the world for pumping water, but it is a very dependable method of pumping deep wells, and if more wells were properly piped there would not be as much prejudice against the use of the air lift.

One of the large railroad systems of the southwest, whose source of water supply is almost wholly from deep wells and which uses deep well pumps, employs, and always has, a corps of trained mechanics, subject to call night or day, for the repair of broken pump rods, working barrels and valves. From a record covering several years they have found that the average cost is $38 for each time a well has to be pulled. What can it be in isolated cases where there are not trained men and a full equipment of the proper tools, etc.? This road is gradually changing over to the air lift, which has all working parts above ground and in plain sight of the pump man at all times.

The writer has known of cases where a compressor has been sold to pump a well, and the purchaser has been told that all that was necessary was to put an air pipe down into the well to such a depth that 60 per cent of it would be submerged at all times, and all that would then be necessary would be to start the compressor and turn on the air, and an abundant supply of water would be forthcoming. Yet the proper designing of the piping of a successful air lift plant is as much a mathematical problem as is the designing of the proper wiring for an electric installation.

Much depends upon the proper flow areas—in fact so much that the external area of pipe couplings must be taken into consideration.

It has always been supposed until recently that it was not possible to employ the air lift in cases where there was a long horizontal discharge at the surface and then a vertical discharge into tanks, etc. This is now possible, and is not covered or protected by any patents.

THE FOLLOWING IS A good rust preventive for steel: 16 parts turpentine, and 1 part caoutchouc dissolved by a gentle heat. To this add 8 parts boiled oil, stir and at the same time bring to the boiling point. Apply with a brush after the manner of varnishing. This coating can be removed by the use of turpentine if desired.

OPERATING AIR COMPRESSORS

By C. R. McGahey

TODAY the engineer must understand the handling of the air compressor as well as other lines new to the engine room. In the handling and repairing of air compressors it is not as easy to make a good job as with some other of the apparatus connected with the engine room. Compressed air is quite difficult to hold and many of our compressors are wasteful in fuel due to the fact that their valves are leaking badly. Some constructions are such that continual repair is necessary.

The main thing in keeping up an air compressor is to keep the valves running properly. The valves are usually of the cup or disk form; the disk valve when allowed to wear and get too much throw will soon hammer itself to pieces, and the same is true of

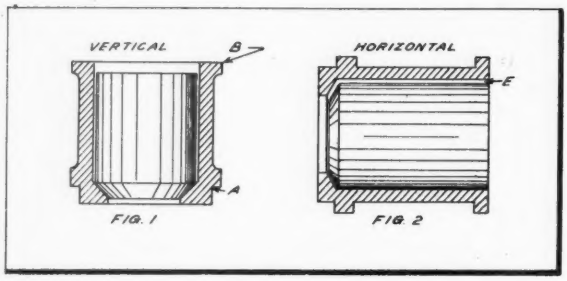


FIG. 1. VERTICAL COMPRESSOR VALVE
FIG. 2. COMMON HORIZONTAL COMPRESSOR VALVE

the cup valve shown in Fig. 1. As the taper seat wears down, the retaining cap should be let down so as to reduce the throw, which can be done by cutting down the top of the cage as shown at B, and by regrinding the seat by the use of flour of emery, we can soon reseat the valve and have it in good working shape.

I have often found compressors where the cage had been allowed to become loose and hammer between

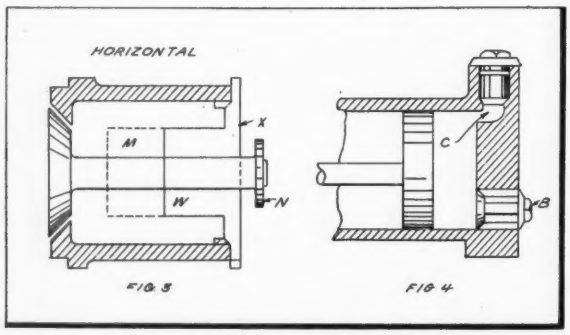


FIG. 3. POPPET TYPE OF HORIZONTAL VALVE
FIG. 4. ARRANGEMENT OF VALVES IN COMPRESSOR CYLINDER

the points A and B until the cage seat was gone. This is not an uncommon occurrence and one that sometimes costs a new compressor head. These cages should always be held firmly in place and the throw of the valve should never be allowed to become too great.

The compressor with the horizontal valve arrangement is the one that is the more difficult to handle and keep in good working order, and more especially so on machines that run at a high speed. Figure 2 shows a horizontal cage and its wear. For instance, a cone or cup valve is the kind generally used and this will wear down from the constant movement and soon the seat will be worn oblong as the valve wears down; then as the valve is forced against the seat it necessarily will have to rise at the point E in order to come up against the seat squarely and the result is a big slippage of air, consequently a much lower efficiency than we should have. This is one of the reasons that the valve that sets on an agle of 45 degrees works much better than when set horizontal.

Figure 3 shows a type of valve that is now much used on compressors, the valve being made from a solid piece of steel and the guide X being made in 2 sections, this makes quite a good valve, but one fault with many of them is the lack of support on the part W, allowing the valve to shift around while working and not seat with any degree of certainty. I have overcome some of these faults by extending the guide portion as shown at M, in the illustration, and by making this change the valves were made to work much more satisfactorily and with less loss from slippage.

This valve is much like the cup valve. It should not be allowed to get too much throw, if so, it will soon wear out the seat. Many of our compressors that are now working badly can be bettered by some slight changes of this kind. The style of head as shown in Fig. 4 will wear with less trouble, although we have a little more clearance at the point C.

MASONRY AND FOUNDATIONS

By Thomas M. Sterling

I HAVE been a member of the Practical Engineer family but a short time, and perhaps have no license to butt in the various discussions, but I will endeavor to relate a kink or 2 we worked in order to accomplish some masonry and foundation work.

Like Mr. Benefiel, in the November issue, we found it necessary some time ago to remove a section of tile wall in order to make room for a couple of large boiler feed pumps. This wall separated the engine room from the boiler room, and was about 50 ft. high by 60 ft. long. As we were desirous of getting the pumps in the nearest possible location to the feed-water heater and wanted to set them side by side in order to economize in floor space as well as pipe fittings, and also get the most convenient arrangement possible, it was necessary to remove a section 10 ft. high by 20 ft. long out of the middle of this wall right down to the floor.

In order to do this, we first marked out the section on the wall, and in the course of tile immediately above the 10-ft. mark we broke out several holes the size of a half tile, and at such intervals as best to take care of the weight of the wall above. Through these holes we ran 6 by 6-in. timbers 8 ft. long, and under each end of each of them we set a 6 by 6-in post and keyed them up good and tight. By this method we supported the wall easily while we cut out the tile below.

As soon as the tile was all removed we at once built an 18 by 18-in by 9-ft. form at each end of the opening in such a manner as to enclose the projecting ends of the tile and filled them full of concrete to serve as posts to support the 12-in. by 20-ft. I beam that we were going to use as a lintel to support the wall above.

The only 12 by 20 I beam that we had on the job had a 6-in. face, and as the hollow tile in the wall to be supported were 8-in., we took a piece of 8-in. by 20-ft. channel iron and riveted it hollow side down to the top edge of the beam so as to come exactly in the center. This not only afforded us a proper supporting surface for the tile but by drilling holes in the edges of the channel we had an excellent means of fastening the rafters of the roof of the pump room by means of small ell irons.

We rested the ends of the beam on iron plates on top of the concrete posts and then keyed in on top of the channel iron with pieces of brick or tile until we had the entire weight of the wall on the beam. After removing the supporting timbers and plugging up the holes we had a first class job.

For the roof of the pump room, we used 2 by 4's bolted by means of the ell irons above mentioned at the top ends to the edge of the channel iron. After laying out the outline of the room on the floor, which was of solid cement, we drilled holes at proper intervals, about 4 in. deep and set ½-in. bolts in them

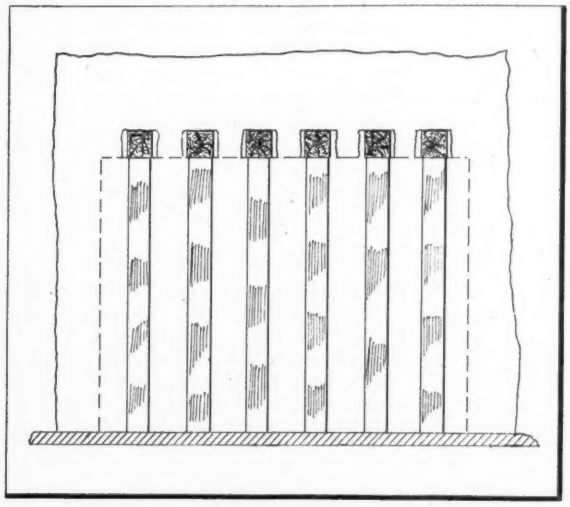


FIG. 1. TEMPORARY SUPPORT OF WALL

and ran babbitt metal around them, leaving them projecting enough to fasten pieces of 2 by 4 on them to be used as sills.

It was then an easy matter to erect a substantial frame work and, by using matched lumber for the siding, we had a dust-proof partition. After cutting the opening for the necessary doors and windows and giving it a couple of coats of paint, we had a dandy pump room.

As it was necessary to put one of the pumps in operation at once, and before we had time to put in foundations, we blocked them securely and perfectly level on timbers of the proper height and location for all the pipe connections, and in such manner that we could excavate under them for the foundations and set the forms. When all was ready for the foundations we took 1 part Diamond Portland cement, 2 parts good sharp sand, 4 parts of crushed lime stone, about 1½-in. size, and after dry mixing several times, we added sufficient water to make, by mixing again, a good slushy consistency and filled the forms to within 1 in. of the base castings of the pumps, the anchor bolts being suspended through their respective holes in the base castings.

The foundations were allowed to set for about 60 hr. and, as we had been careful in keeping the pumps level every way, we had only to wedge them off the timbers and grout them in. After the grout had hardened properly, the forms and timbers were all removed, the ragged edges smoothed up, and we had a fine outfit.

This work was all accomplished with one of the pumps in continuous operation. We were careful, of course, to run slow enough to avoid all jar while the grout was setting, the liability of this being almost entirely eliminated by the fact that all pipe connections were already made and were sufficient anchor in themselves.

Foundations of concrete, if properly mixed and put in by persons up in the business, excel all others for

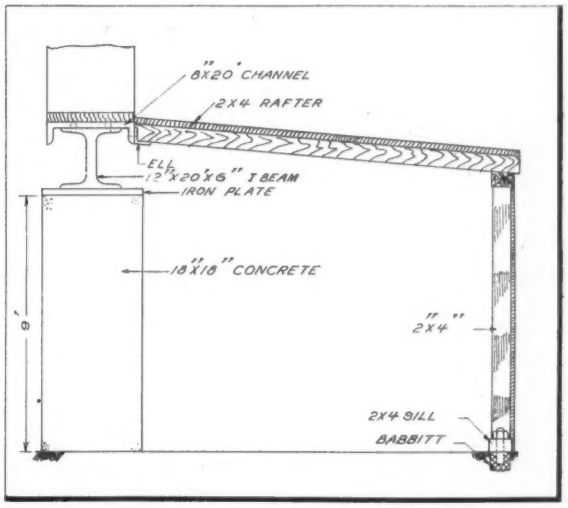
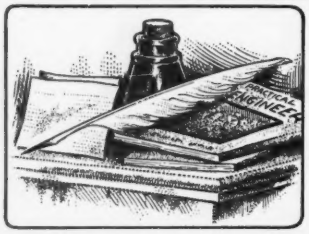


FIG. 2. FINAL ARRANGEMENT OF LINTEL, RAFTERS AND SILLS

durability. It is a fact that they are penetrated by oil and moisture to a certain extent, but very seldom to any detrimental degree. Always use good cement, and good, irregular shaped, rough surfaced stone; river gravel or stone from river beds is usually too smooth and round to allow good adhesion of the cement. Always use good sharp sand, free from clay. Never,—No Never! undertake to use cinders in place of stone in concrete or you certainly will have a bad job; one that will be greatly affected by cold and frost and one for which you will always be sorry.

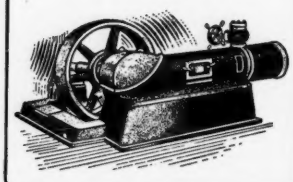
INSTEAD OF USING putty or clay for plugging up the ends of the boxes while the babbitt is being poured, some old asbestos pipe covering may be ground up and mixed with cylinder oil to the consistency of a stiff putty. This mixture has these advantages: It is proof against the softening influence of heat, sticks far better to the box than either putty or clay, never "blows" when the hot metal comes in contact with it, and can be used over and over without loss or hardening.

IT HAS BEEN shown by accurate experiments in the laboratory that the flow of gasoline through a nozzle is 25 per cent slower at winter temperatures. Because of this tendency, and because a richer mixture is called for than in summer, it may be necessary at the beginning of the cold season to have the carbureter adjustment changed.



Letters from Engineers

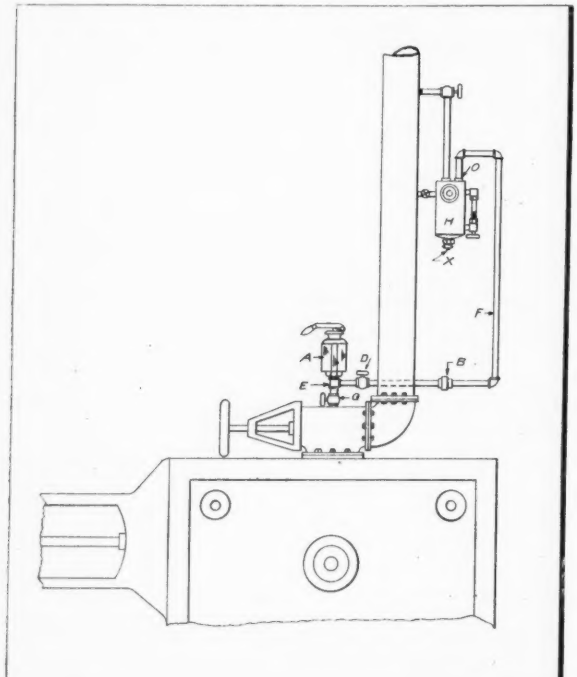
Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



A LUBRICATOR IMPROVEMENT

WHEN reading over the December issue of Practical Engineer, I read of a handy lubricator device of Mr. Richmond, which, no doubt, is a very good thing, but I think that mine is a trifle better, as almost all engines are equipped with a pump to use in case of emergency. With a little pipe, a valve and a couple of fittings this device can be made, and it saves time and oil as well.

Between the oil pump A and the throttle or steam chest insert a valve G and tee E. In the ½-in. pipe F insert valve D and union B. Pipe F enters the lubricator at the filling hole O. To fill the lubricator close



HAND PUMP FOR FILLING LUBRICATOR

valve G, open D and plug X, and pump the oil from A into the lubricator H. In case the lubricator fails and it is desired to oil the cylinder by hand, close valve D, open G, and then pump the oil direct to the cylinder.

Martin McGerry.

ANTI-ECONOMY IN TWO POWER PLANTS

ACCORDING to all technical precedent, there is a never ending hunt to capture all the stray B.t.u. and to put them to work where they will do the most good. This being the case, it will interest readers to know of 2 plants in Massachusetts, close to the plant where I work where B.t.u. are wasted by the million.

Of course, there is an object in wasting all this heat but it would seem that there should be a way to avoid it. In the first plant a soft coal producer, scrubber and rotary kiln are used in a lime works having a vertical water-tube boiler and high-speed engine. The engine is used to crush stone and keep the kiln revolving, and the boiler makes steam for engine and gas producer.

Gas from the producer passes from the scrubber into one end of the kiln, where after ignition it burns the rock into lime, then passes through a large dust chamber through the boiler and out of the stack. The amount of heat developed is therefore regulated according to the needs of the kiln, and the boiler makes so much more steam than is used that one or both of the 3-in. safety valves are blowing all the time. As it takes about 10 lb. of coal to keep a 3-in. safety valve blowing 1 minute at 100 lb. gage pressure, which is carried, one can well see how great is the waste.

Yet the engineer tells us that after burning the rock into lime at the rate of 300 bbl. in 24 hr., before the gas reaches the boiler, he can evaporate more water per pound of coal than is done in most plants with the fire directly under the boiler.

The second plant is a 6000-kw. power station generating power to run trains through the Hoosac Tunnel. The steam end consists of 2 3000-kw. turbines, which were designed for 200 lb. gage pressure, and 150 deg. superheat; for some reason they carry only 180 lb. on the boiler and it seems to the observer that the superheater is making steam instead of superheating the steam when the boilers are working hard. The boilers are of the almost vertical tube design, equipped with underfeed stokers, operated from a countershaft of the turbo-blower, which furnishes a draft in the ashpit of 5 in. of water. The products of combustion, after leaving the boiler and superheater, pass through an economizer and then through an induction fan, which forces them outdoors.

With this combination and a 4-ft. fire, an overload does not bother the steam end, but the load will go from full or overload to friction load and stay there sometimes an hour; then go back to an overload again, and before the fire can be got into shape, the pressure is down 25 or 30 lb., and, if the circuit breaker does not go out, the condenser will pull the seal out of the turbine which means stop and get the turbine sealed again before the load can be thrown on.

When the load goes off and the fires are at a white heat, the safety valves are blowing before the blower has stopped. It was partly to overcome these conditions that the chief engineer put a water rheostat out in the condenser and feed-water pond. This rheostat consists of 2 electrodes and a barrel on a raft anchored in the pond. When the railroad load goes off the current is automatically switched into the pond and disappears as heat.

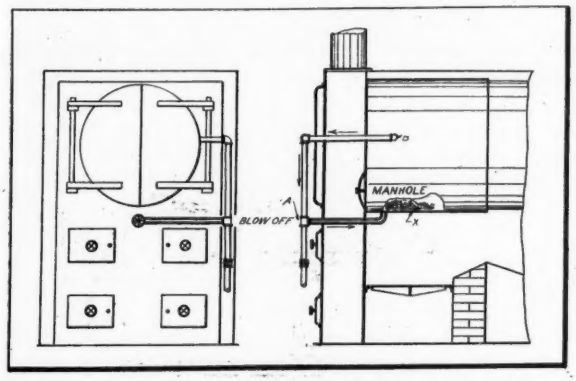
This helps matters in the station and furnishes us with a good display of fireworks when the current is thrown into the pond on a dark night, but it is only another case of B.t.u. getting away without doing useful work.

A. N. Griswold.

STEAM LOOP VS. TRAP; LOCATION OF BLOWOFF PIPE

IN the November issue W. J. S. asks as to whether a steam loop will be successful for draining separators in his proposed steam plant. The answer given is that the steam loop is for a different purpose and would not be suitable for taking condensation from separators and returning it to the boilers.

I do not agree with this answer, but say that the Holly steam loop is suitable for this purpose, and in proof of my assertions will say that the plant in which I am now working has the high-pressure piping drained entirely by the Holly steam loop, a description of which appeared in the May, 1911, issue of Practical Engineer under the caption of Holly Steam Loop and Gravity Return System, to which I would refer W. J. S. In this plant the loop is connected to 4 separators, placed just above the throttle, and is also connected to



BLOWOFF PIPE WITH CIRCULATOR LOCATED IN FRONT OF BOILER

all low points on the header, also to the steam lines, to the various pumps. The water returns to the boiler by gravity and in the 3 yr. that this plant has been running it has given no trouble, except for 1 piece of split pipe and 1 or 2 defective valves, and requires no attention. The steam pressure here is 100 lb.

By reference to the plan view shown in the above mentioned article it will be seen that the only provision necessary to connect to a separator is to run a single 1- or 1½-in. pipe, depending on the size of the separator, to the receiver below the floor. In a plant with large engines located some distance from the receiver the drip pipe should be larger and the receiver set low enough to give a good head between the separator and receiver. This head pressure due to the column of water in the drain pipe will counteract the drop in pressure in the steam line. An equalizing pipe is connected from the header to the receiver. Also, care should be taken in laying the drain pipes that no water pockets or seals are formed.

I prefer the steam loop to traps for light-pressure drainage and would advise W. J. S. to take the matter up, if he has not already done so, with the Westinghouse, Church, Kerr Co. of New York, who installed the above mentioned system.

In regard to the blowoff pipe arrangement as shown by Chas. H. Taylor in the November issue, I believe it is a good one, there is one good reason for it that he did not mention, and that is that it is more effective in blowing out the scale. In 9 cases out of 10 when a boiler is opened for cleaning, a pile of scale is found at about the point marked X in the cut, and a blowoff connected at this point would surely stand a better show of getting that pile of scale than if placed at the rear end in the usual position. This, I believe, will help to do away with bagged and burned sheets which are frequently found in fire tube boilers.

Another point that makes it appeal to me as a good idea is that with the blowoff at the rear end it is covered with soot and ashes containing certain chemicals which, when wet, set up external corrosion on the iron blowoff pipe. Even when brickwork is placed around the pipe, this external corrosion is the cause of more blowoff pipe renewals than any other cause. With the pipe at the front end this would not be the case, also any leakage around the blowoff would be readily detected.

There is a sectional covering on the market made especially for blowoff pipes which could be used to protect the pipe on the front end if deemed necessary. I would also suggest a circulation pipe connected at the tee A outside the boiler and tapped into the boiler at the point B below the water line to set up circulation and keep the pipe free from scale over the fire and prevent its burning. The scale in the pipe would be carried into the boiler from the pipe, the column of water in the circulation pipe being heavier, due to its lower temperature, as it would be cooled by the surrounding air. The circulation would be as shown by the arrows.

In regard to his suggestion of not placing a manhole at the rear end, I believe it is the present practice of boiler manufacturers to place the manhole in the front end as the cut shows. J. C. Hawkins.

CLEARING THE RETURNS

ANSWERING A. C. G. in the December issue asking for comments or suggestions, as to the best way to get the return water out of the heating coils and into a tank without having so much back pressure on his engine, I will give suggestions from my own experience.

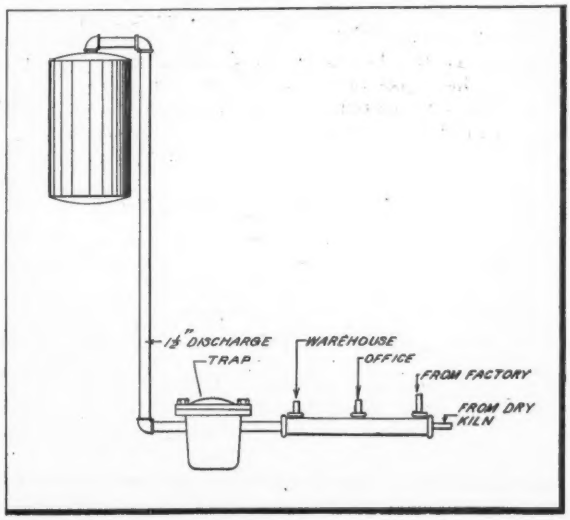


DIAGRAM OF CONNECTIONS FOR RETURNING CONDENSATION

He does not state if he uses all of the exhaust or not, but I have an idea he uses a back pressure valve.

If he will pipe his separate returns into a large header or a receiver he will find it best. To this receiver or large header connect a 1¼-in. condensing direct-return trap which will drive the condensation to his open tank above. As he has an engine he has

10 lb. or more of boiler pressure, and 10 lb. is enough to lift the water 20 ft. I would use a 1½-in. pipe for discharge to the tank, as there is less friction in the larger pipe.

Of course, I have taken it for granted that he has some kind of water pressure as the condenser will have to have cold water pressure greater than the radiator pressure.

Referring to the diagram; the header can be made out of 5-in. nipples about 6 in. long and tees. I would suggest 3 or 4 connections to the header and a swing check in each line, also a valve (standard gate). The header and trap should be set at the lowest point of the radiation, just enough for the condensation to drain to it. Put a pet cock on the header or trap, which is opened when first starting up, then closed. After all connections are made, open the steam valve to the trap. Open the pet cock, and if the trap does not trip right away push it down enough to admit the steam, then open the water valve that goes to the condenser, a little. The steam is condensed, a vacuum formed and the condensation pulled out of the coils. As the trap fills it tilts down, admitting the steam and shutting off the water. As the steam drives the water out of the trap it tilts back, shutting off the steam and opening again to water. The up-keep of water for the boiler can go through the condenser, as the more water the greater the vacuum.

I have done away with my receiver pump and use it for an auxiliary. I have one trap at the lowest point and one 5 ft. above the bottom of water glass on boilers. We have 300 hp. boilers and the traps give less trouble than the pumps, as there is no oil to contend with. The top trap is non-condensing, but I have piped the discharge from it to a point on the low-pressure side of the reducing valve, and it is saved.

There are several kinds of tilting traps on the market that would give good service. We use the Morehead, which is as good as any. J. D. Andrus.

UNEVEN BACK PRESSURE

I SHOULD like to have the opinion of readers as to the cause of the high back pressure on one end of the low-pressure cylinder, which I indicated some time ago. Several indicators were used with the

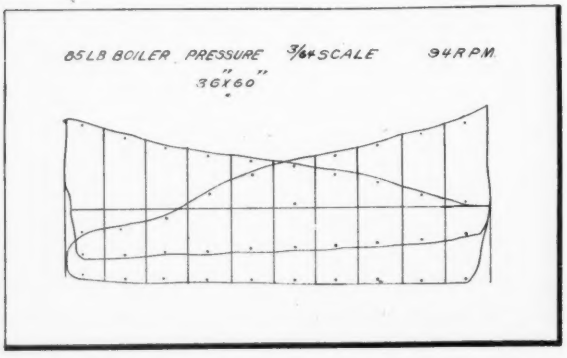


FIG. 1. CARD SHOWING HIGH BACK PRESSURE ON ONE SIDE OF LOW-PRESSURE CYLINDER

same result the cylinder was vertical 36 by 60 in., running at 94 r.p.m., 85 lb. boiler pressure and about 50 yr. old, the cylinder stood on cast-iron plates which rested on stone bases as shown in Fig. 2. Both cylinders were equipped with slide valves. The engineer of the plant said that the engine had run like this for 15 yr. Richard Howarth.

PUMPING FROM A RECEIVER

IT is well known that hot water cannot be pumped unless the supply is above the pump, as the vapor rising from the water destroys the vacuum in the cylinder, so a receiver tank should be located over the pump a distance of more than 5 ft., as will be proved later; thus giving the water a chance to seek its own level. A pump so located only waits for the suction valves to open to fill the cylinder with water.

Only one place then exists where vapor can form; this is in the clearance space of the water cylinder. Theorists tell us that no steam can arise from a body of water until the pressure under which this body of water is confined has fallen to a point corresponding to the pressure of steam at the given temperature, which, in this case, is assumed to be 212 deg., as a receiver tank is open to the atmosphere when not under a vacuum and the corresponding pressure is 14.7 lb. absolute.

As water is practically incompressable, as soon as the piston starts its stroke the pressure rapidly falls

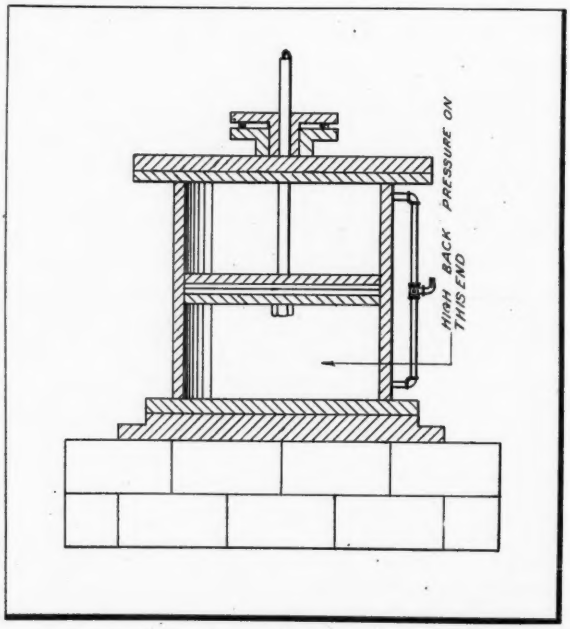


FIG. 2. SUPPORT OF LOW-PRESSURE CYLINDER

on the suction side of the piston until it reaches the pressure of 14.7 lb. absolute, but as it falls below this point the water in the clearance space is turned into steam and the drop in pressure is not so rapid as the steam, which has formed, expands and fills the cylinder.

The suction valves will remain closed until the pressure due to the head plus the absolute pressure in the tank, overcomes the absolute pressure in the cylinder plus the force holding the valves to their seats.

This point will depend on the vacuum in the tank and the height of the tank above the pump and probably in the assumed case does not occur until the piston has completed the larger part of its stroke.

Assuming a 5-ft. head and a perfect vacuum in the tank, which is improbable, the absolute pressure in the suction chamber tending to open the suction valves will be about 2 lb. per sq. in. absolute, as a column of water 1 sq. in. in cross sectional area and 1 ft. high weighs 0.434 lb. at a temperature of 62 deg.; it

will be somewhat lighter at 212 deg. We will assume that it weighs 0.4 lb., which multiplied by 5 ft. head equals 2 lb.

This would require a vacuum of about 28 in. in the pump cylinder before the pressures are equal, and taking into consideration the smaller area exposed to the tank pressure, due to grids in the valve seat, and tension of the springs, it will require a higher vacuum in the cylinder before the tank pressure will force open the valves.

As a 28-in. vacuum is an improbability if not an impossibility with a duplex pump, it is not difficult to see why a pump, working under these conditions, looses its water. It is evident then that the head upon the pump must be greater than 5 ft. when a receiver tank is subject to vacuum pressure. The proper head would be that which gives a pressure equal to 14.7 lb. plus the pressure necessary to open the suction valves.

C. B. Hudson.

BOILER FEED PUMPS

A GOOD pump to feed water to a boiler is the heart of a power plant and it is just as important to a pump handling hot water under high pressure that the piping be constructed right as it is that the veins and arteries in the human body be in perfect order.

Many pumps are installed with piping in such condition that satisfactory service is impossible. The

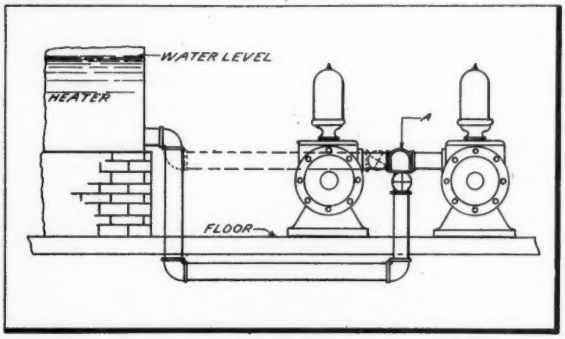


FIG. 1. IMPRACTICAL SUCTION PIPE ARRANGEMENT AND REMEDY

pump may be the best that money can buy, but if installed with a system of piping which is full of pockets and of wrong size, trouble will result.

As a matter of course hot water should always flow to the pump and the more head allowed the better will be the service.

In Figs. 1 and 2 are shown 2 diagrams of suction piping which came under the writer's notice and which never worked satisfactorily until they were changed as shown by dotted lines.

Figure 1 was installed as shown in order to have a passage way between pump and heater. While connected in this manner we could not pump hot water, although having about 3 ft. head. The only way the pump could be operated at all was to install a small cold water connection at A, and with this cold water kill the steam that was continually being generated in the pipe under the floor. Steam would form in pipe, and when it would come to pump, the latter would lose its water and often break. After the pipe was changed to the position shown by dotted lines there was no further trouble, while pumping water up to 212 deg. F.

Figure 2 shows a similar construction, but not quite so bad. In this case there was no excuse for dropping the pipe below center line of suction, as there was ample head room, in fact, it would have made a better installation if pipe had been placed over head. The trouble with this piping was the same as in Fig. 1, for because of the drop the steam pocket formed and made pumping impossible except by opening a cold water valve at B. All trouble disappeared after changing the pipe to the position shown by dotted lines.

Below are given several don'ts for suction pipe installation.

Don't install any part of a pipe below center of pump if hot water must be pumped.

Don't decrease the size of the pipe. Make it larger if to be of any length.

Don't install a long suction pipe. Set the pump as close to the heater as possible. If you must have a

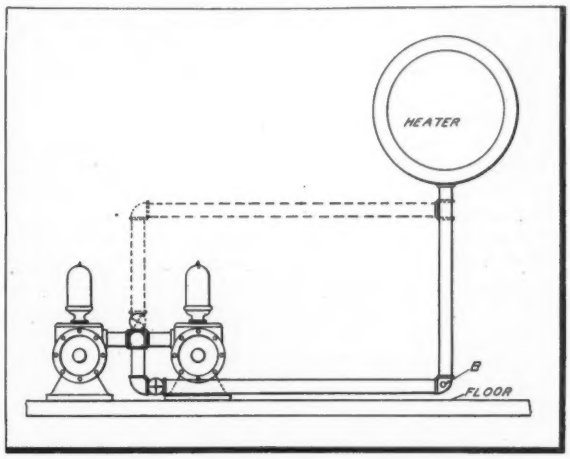


FIG. 2. PUMP SUCTION THAT GAVE TROUBLE AND ITS REMEDY

long pipe, then provide a small vacuum pump to free the pipe of air and vapor.

Don't use a globe valve, nothing but a straight opening gate should be used.

Don't try to use pressure on an open heater, for at certain times a vacuum will be formed and the pump will lose water and probably be broken.

Frederick L. Ray.

LICENSE LAW INJUSTICE IN MASS.

IN the November issue of Practical Engineer, Mr. Howarth states his experience in trying to get an engineer's license. He says that he thought it was the law that a man must hold a fireman's license before he can get an engineer's license.

Now, a man must hold some kind of a fireman's or engineer's license to get a special license, but a man with proper experience should have little difficulty in getting a first-class engineer's license.

I can't understand how an inspector would dare to turn a man out with the experience Mr. Howarth claims he has had, because the law states: "The applicant shall be given a practical examination, and if found competent and trustworthy, he shall receive, within 6 days after the examination, a license graded according to the merits of his examination, irrespective of the grade of license for which he applies." Also, the law states: "A person who is aggrieved by the action of an examiner in refusing or revoking a license, may appeal therefrom to the remaining examiners, 3 or more of whom shall together act as a board of

appeal, and shall have power to hear the complaints and pass upon the subjects of appeal. If appeal is taken it must be within one month after the decision of the examiner. The applicant may have one first-class engineer present during the hearing of his appeal, but he shall take no part therein. The decision of the majority of such examiners so acting as a board of appeal shall be final if approved by the chief of the district police."

The first engineer Mr. Howarth met could and would have told him this, and in a case like his he should have gone before the board.

He says he fired for a man who held a special license for a first-class plant, that could neither read nor write. It is true there are a few such men holding down jobs with special licenses, but they got them long ago, and if they are not practical men the firms they work for must be very poorly managed to keep them.

Mr. Howarth claims to be very proficient in valve setting, indicator practice, etc. A man may be well posted on these things and know practically nothing about other very important things. The hardest part of the examination of an engineer is on boilers and their care and management, and this is as it should be, because the boilers are the most dangerous part of the equipment of a steam plant.

My business with the Massachusetts examiners has been very pleasant, and I have met several of them. I came to Massachusetts about 1 year before Mr. Howarth did, and although I had had 6 yr. experience and in some respects it had been very narrow. I applied for a second-class engineer's license, and it took me about 15 minutes to find out that I lacked the experience necessary for such a license. I got a third-class engineer's license at this time, and then I got busy looking for a position and experience.

I have been examined 3 times since, and I have seen several men examined for the lower grade licenses, and I have never had a question asked me, nor have I heard any question asked at any examination that did not bear on the applicant's knowledge of the safe operation of boilers, engines, etc.

I have seen one of the inspectors help men who got rattled, in every way that he could, without answering the questions himself, although no inspector is under any obligation to do this, and yet I have heard this inspector called a hard man from whom to get a license.

I notice that very few of the complainers have ever taken advantage of the right to appeal. I am sure that if I were used as Mr. Howarth says he was used, I should certainly appeal to the board.

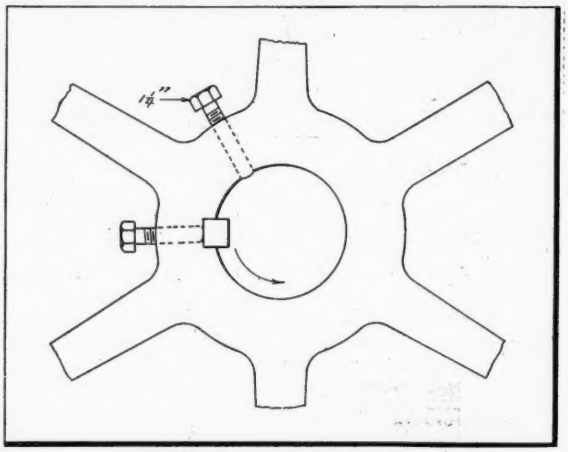
If Mr. Howarth will remember that the inspector has nothing to judge an applicant by but the answers the applicant makes to his questions, perhaps he will find the reason the inspector turned him out with a fireman's license. Wilmer R. Hersey.

THAT LOOSE FLYWHEEL

I NOTICE in the November number Mr. Swearingen's trouble with his flywheel. Some years ago the writer was called to remedy a somewhat similar trouble, except that the wheel ran fairly true on the face, but ran out sideways and had a knock at both ends of the stroke, caused by the key not fitting sideways, thus allowing the wheel, at the end of each stroke, to bring up hard on the opposite side of the key by reason of the increased momentum of the wheel over the crank shaft at that point. The accompanying sketch shows how I fixed it.

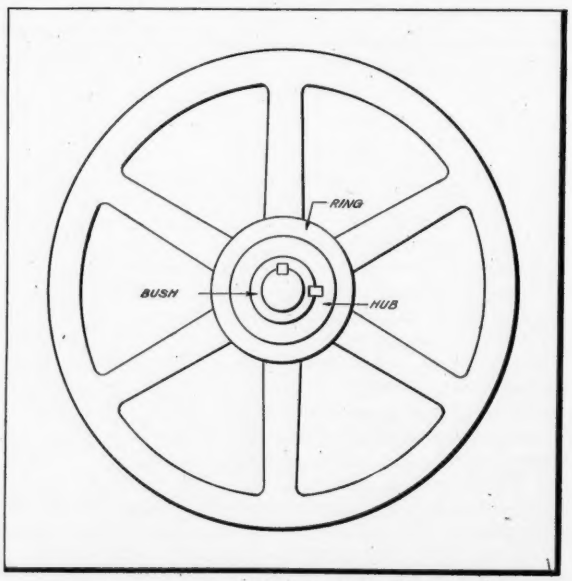
I put a 1¼-in. set screw with 10 threads per inch on each end of the hub over the top of the key, in order to keep the key down solid in the shaft keyway, and in tightening the set screw I turned the wheel so the key was nearly underneath, thus avoiding the necessity of lifting the wheel in setting the key.

I then put 2 more set screws, the same size, one on each end of the hub to hold the key slot in the wheel tight against the driving side of the key to prevent the wheel lurching forward at the end of the stroke; these 2 set screws happened also to be in the



METHOD OF TRUING UP FLYWHEEL

proper position to set the wheel about true on the side. I also faced the portion of the hub true with the threads for jamb nuts; of course, these set screws need some attention until they were well bedded, but for 6 yr., to my certain knowledge, there was no more trouble. My reason for using a finer thread was that



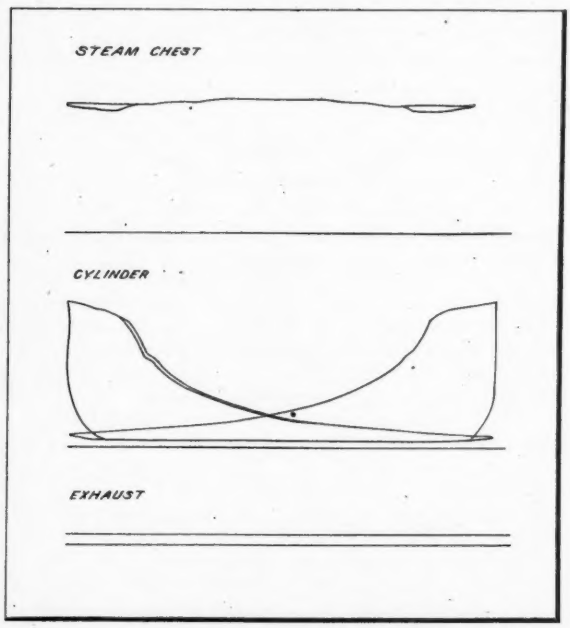
BUSHING AND RING TO CURE FLYWHEEL WABBLE

it would not be so liable to back off and also would draw up tighter. A somewhat similar arrangement with the set screws as large as the metal would bear might answer in Mr. Swearingen's case, with the addi-

tion of a sheet steel liner to get the face to run more nearly true, as it is evident that either the bore or the shaft, or both, must be worn considerably, providing the wheel ran true originally, and if it ran true originally, I would not consider it very safe, as the extra weight on one side might spring the shaft, thereby causing any amount of extra trouble. The only other remedy would be reboring the wheel, truing up the shaft in its bearings and making steel bushings to suit, or a new shaft. Wm. S. Luckenbach.

Mr. McGahey's loose wheel article in the November issue of Practical Engineer brought to my memory how a loose flywheel was fixed in a plant where I worked. The engine was a high-speed single center crank, 65 hp., running 360 r.p.m. It had a flywheel and generator at each end of the shaft.

One day one of the flywheels was discovered to be quite loose; when the engine was shut down, the key was loose and was driven home. This helped for a while, but the trouble soon returned. When the key was removed it showed considerable wear; then it was decided to take the wheel off, which was done. A steel bushing was made to fit the shaft and shrunk and keyed on. The wheel was taken to the machine shop, where the hub was bored to fit the bushing.



CARDS FROM A CORLISS ENGINE

The wheel was keyed on the bushing and a band of iron 3 by 2 in. was shrunk over the hub. It is needless to say that the wheel did not wabble when put in service again. Fred Wagner.

FROM STEAM CHEST TO EXHAUST PIPE

HEREWITH is a complete set of indicator cards from a 16 by 36 engine—Corliss,—including those from cylinder, steam chest, and exhaust pipe.

Tom Jones.

WRONG USE OF THE CONSULTING ENGINEER?

ON a recent visit to an engineer friend, the writer had the query handed to him in a rather savage manner by said friend, "Why is a Consulting Engineer?" On investigation I found that the question was prompted by that bane of operating engineers, viz., outside supervision of the power plant. The particulars in the case were extremely exasperating to the man in charge.

To make it clear, the engineer whose name is George, came here some 3 years since. The business had been very profitable with but little or no attention to economy, but the time came when it was necessary to cut off all needless waste.

As the power plant was notoriously inefficient, it was the first to receive attention. After careful investigation it was decided that an up-to-date engineer was the first essential, and George was selected without any solicitation on his part.

The plant was old, dirty, and ate all the coal that could be put into it, and was far from an inviting place. The prospective position, however, held out sufficient inducement to cause George to accept, with a distinct understanding that he was to be given a free hand, the wisdom of which move was soon apparent.

Shut downs became a thing of the past; the old engines were put in as good condition as possible; furnaces were straightened up, the boilers cleaned of scale and soot; the engine and boiler room force brought to a point where they cared more for cleanliness, and efficiency, than for pay day and the sound of the whistle. The fuel cost dropped amazingly, and the factory was kept warm the entire winter, which was a cold one, for the first time in the memory of the oldest employe.

That the firm, from office boy to president, were well satisfied was evidenced by the fact that George was requested to plan an entire new plant, to see what saving could be made. The plant was built under his supervision, with such engines, boilers, generators, etc., as he selected placed therein. On the whole it has been very satisfactory, developing a horsepower on as little cost as plants of greater size. So far as the writer knows no fault has ever been found with George or his work, and I was considerably surprised when met by his question, "Why is the Consulting Engineer?"

On inquiry I found that the old superintendent had retired, being succeeded by the president's son, whose connection with the firm had been entirely in the office, and here is where the trouble came in.

One of the first things he discovered was not the need, but lack of a consulting engineer, so he set about at once to supply the shortage. How he did it is best described by George, who said, "Bill, I would not have cared if the new super had hired a sure enough consulting engineer, one who was a graduate of some recognized school of engineering, and had had sufficient experience to superintend my work, but when he picks up one of the 57 unclassified varieties, a man who quit another trade about the time I came here and whose experience has been in 3 different plants in as many years, I wont stand for it. I took the old place when it was a pile of dirt and junk, and no one else wanted it. I built the new plant and started it a year ago, and it has done all and more than was expected of it, and I would be a chump to submit to this 'half year captain' coming in here and telling me what to do. My resignation is on the superintendent's desk, and the sooner I go the happier I'll be."

Here is a case where, to my notion, the profession of consulting engineer as well as operative engineering will suffer a set back, also the young super will gain much valuable but costly experience. A good and

capable engineer will be lost to a firm to which, from the very nature of conditions, he was most valuable.

The consulting engineer, while a bright and agreeable fellow, lacks the necessary experience to assume charge of this plant. The firm involved will not feel kindly disposed toward consulting engineers. The young consulting engineer will be the only one to come out ahead, as he will have some experience from which he can not help but profit by the salary and prestige attached to such a position.

As this is not the first occurrence of the kind that has come to my notice, it seems that engineers should take some action with a view to combating this growing evil. If a firm would think for one moment it would see but small hope of bettering its condition by extraneous supervision if it has competent operators, for 3 very good reasons, of which the first is: No matter how competent the outside man may be, he must in the end depend on the man in charge to a very great extent to carry out his ideas. Second, if the operating engineer is a capable man and has improved his opportunity for education, he will need no outside help to run his plant economically; and 2 to 1 he will not stand for interference. Last, but not least, there are few concerns large enough to shoulder the expense that the salary of a competent consulting engineer will entail on the operating department.

It is not the writer's intention to cast any reflection on the profession of consulting engineers. They are highly necessary when you have a large plant to be designed or a complex problem to be worked out, and you will find few of them who are anxious to take on a supervising job. There ought to be some means of protecting the operating engineer from half baked consulting engineers whose proudest possession is a 5-ft. shelf of books noticeable from afar by their gaudy binding, and these cases are by no means rare.

I know of my own personal knowledge 3 places where this has occurred and not a single one of the professional brethren was possessed of a college degree or membership in the A. S. M. E. or adequate experience. In traveling the state of Indiana you will find a long chain of plants whose operations are governed by a supervising company almost 1000 miles away, and the plants show that there is something to George's question, "Why is the Consulting Engineer?"

Traveler.

GOVERNOR UP KEEP

MANY of our high-speed engines suffer in regulation from the improper adjustment of the governor. One of the greatest drawbacks that a high-speed engine has had is to get a governor that will not only regulate closely but at the same time wear properly, and to maintain these conditions of regulations, we are showing one of the types of shaft governors in Fig. 1 that will regulate closely when properly adjusted.

We had one of these governors that was working sluggish and slow in action, and found that the leaf spring was not lying firmly together; that is, the main leaf, as shown at B, Fig. 2, was under a strain that made it lie separated from the balance of the spring, consequently the action of the spring was uncertain and jerky. The spring yoke, as shown at F, Fig. 1, had slipped and was in the position as shown. This was moved to the point E, and so set as to come across the spring at right angles, and moving this up so as to bring some more tension on the spring and hold it firmly so that the one leaf could not move separately at this point, brought the governor to a perfect regulation.

There are 2 essential elements in any shaft governor, one is the spring and the other is the weight, so one or the other of these being hampered in its action will cause the governor to be inaccurate in its operation and the principal disease of governor is the dislocating of some of the working parts, and this generally comes from wear. We are showing at M on the spring B, in Fig. 2, how the spring will become

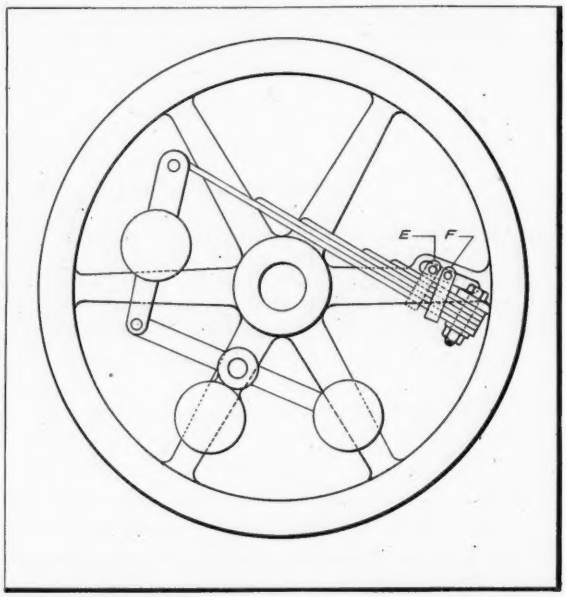


FIG. 1. FLYWHEEL GOVERNOR WHICH GAVE TROUBLE

shifted sometimes and will cause the governor to become uneasy and work badly, by this spring rubbing against the weight some distance from the pivot; all these may look like small points, yet they are the things that give us the poor regulation.

It is not an uncommon thing to find our pivot pin D worn as shown. Many of our governors use a roller

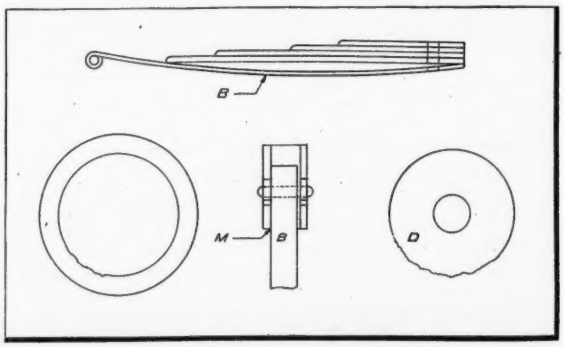


FIG. 2. DETAILS OF GOVERNOR

bearing, and there are but few of our governors that do not oscillate in their running, and this movement will wear the roller into a seat just as shown in the pin D, and, of course, the governor will not make any great change in speed with any degree of accuracy, as this roller will have to be carried over this impression which will go with a jerk.

The bushing that usually goes in the weighted arm is shown at the left, and wears in the same condition

as the pin. I have removed and reversed these pivots so that the wear would come on the opposite side, and by this means made the same bushing and pin run a long time.

There has never been a roller bearing put in a governor that would not wear just in the shape that we have illustrated. Some will wear more than others, due to a more varying load, or perhaps to a more balanced governor, but it is the small points that give us poor regulation.

We have shown in Fig. 3, a common type of governor arm having a central pivot, and this type has had its peculiar wear. One side of the pivot has always worn as shown at N, and, of course, this tends

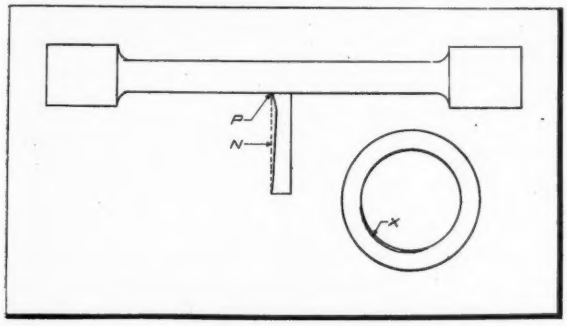


FIG. 3. GOVERNOR ARM WITH WORN PIVOT

to cause the arm to get out of line with the center line of rotation, and the governor begins to hang, and stick, and some will give way with a shock, letting springs and all go. This type usually has the coil spring, which has a movement quite different from the leaf spring, and when any of the parts stick it usually causes the governor to wreck itself.

The bushing, as shown at X, becomes worn on the inside, and the weighted arm becomes more worn at the point P, due to the unbalanced strain from the revolving arm, and this causes the governor to become out of line, and consequently more friction and a retarded regulation.

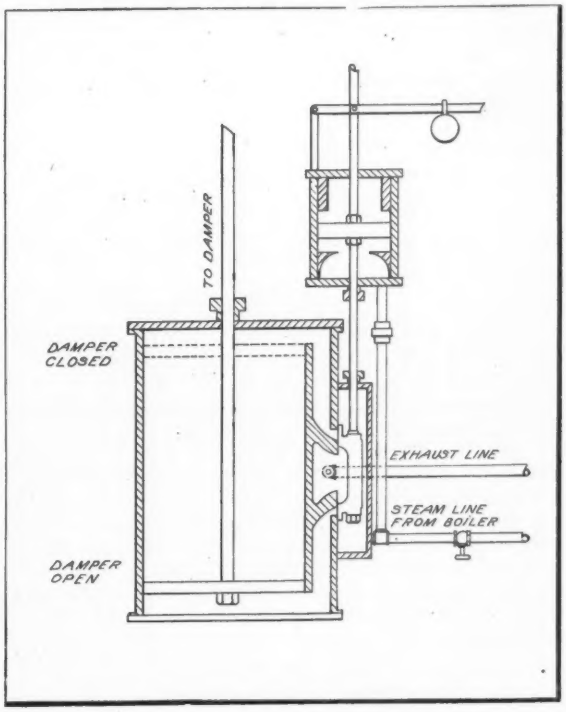
When our governors become unsteady there is a cause for it, and generally can be found in some of the places that I have pointed out. Not long since, I observed a weighted arm governor that would not work as it had at one time, so by simply removing the pins and reversing them, and thus presenting a new surface, the regulation was all right. When a governor is slow to respond and then over regulates, that is, will raise the speed, it is a sure indication that some portion of the governor has become worn and out of line. C. R. McGahey.

DAMPER REGULATOR PLAN

IN reading over a recent issue of the Practical Engineer regarding the place where the damper should be, I notice the article recommends the damper being placed in the top of the chimney. Now, I believe that is the proper place, but I have also studied the results should the damper refuse to work from any cause whatever, and considering all things, I think you will have to locate the damper in such a position that it can be fixed, in case of accident, by the everyday engineer and not by a steeple jack.

Since reading the above article on damper regulation, I have studied on what kind of a damper regulator would be required to work the damper if the regulator was placed near the foot of the chimney. I submit herewith a sketch of a regulator that I think can be used to advantage either for a damper in the flue or at the top of the stack. The only difference in one for the flue and one for the stack would be in the size of the steam cylinder, as more pressure would be required to close the damper at the top of the chimney, if the regulator was near the foot.

This is not a damper regulator that has been made and put in working order, it is only an idea. I have neither the time nor the material to make one, but thinking some of the readers may have both the time and material, I wish to submit my idea to readers of Practical Engineer. The sketch speaks for itself There is just a little steam lap on the valve, say 1/32 in. on each end, the pressure regulator has just enough travel to open and close fully the slide valve. One advantage I claim for this device is that you do not have to depend on a varying water pressure to open



AN IDEA FOR A DAMPER REGULATOR

or close the damper. There is only one connection and that is a steam connection, the action being positive for opening or closing. John Mitchell.

PAINTING AN OLD BRICK WALL

THE first thing to do is to get every particle of loose stuff from the walls, which may be done with a coarse fibre brush; then dust off clean. If you have a lot of old paint and enough to do the job, thin it down with oil and a little benzine, strain, and apply quite thin to the wall, says Master Painter. Brush this well into the surface, and let it have several days to become hard. The next coat should be a lead paint, of fresh materials, with raw oil and just enough driers to dry it well in reasonable time. A little turps also will be an advantage. This will now give you a good foundation for whatever color of paint you may want to apply.

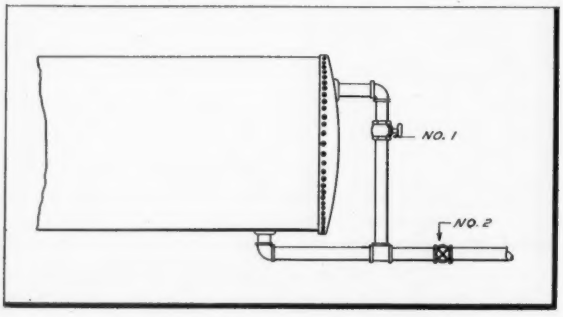
Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

Blowing Down Through Circulating Pipe

THE rough sketch is to represent a boiler with a circulating pipe from the top of the flues to the bottom of the boiler. When I open valve No. 1 and then valve No. 2, what prevents the scale in the bottom of the boiler from blowing out? When I close valve No. 1 the scale will blow out all right, what is the reason, is there more pressure at the top than at the bottom? L. L.

A. The difficulty which you have in blowing down the boiler from the circulating pipe is one of the water



ARRANGEMENT OF BLOWOFF PIPE

flowing through the pipe of least resistance. You will note that the pipe leading directly to the blowoff will probably be filled somewhat with scale and its resistance, therefore, is greater than the one leading from the surface of the water. Therefore, when valve No. 1 is opened first and No. 2 afterwards, the water will run from the surface rather than the bottom of the boiler.

Plant Improvements

WE are contemplating improvements of our plant this summer and more power is required. We are now installing stokers under our Sterling boilers but will have to have steam engines or turbines for electric work of about 500 kw. We have considered a cross compound of the most economical make and then comes a turbine man and claims a big economy over the steam engine, if we can maintain a vacuum of 28-in.

Well, I claim that 28 in. is hard to get in the summer as we have river water for supply and this water would average about 70 deg.

What is your opinion of the economy of the steam turbine with 28-in. vacuum and of a cross compound engine? We carry a steam pressure of 150 lb., and is it good economy to put turbines in stages, say for this plant 2 turbines, 1 high and 1 low-pressure with 25-in. vacuum? How would this compare with the steam engine with 25-in. vacuum. M. J.

A. It is a little difficult to make a reasonable recommendation without knowing more of your present steam plant. You say that you want about 500 kw. additional, that your steam pressure is 150 lb. and that you are considering a compound engine and a turbine. What is wise to do depends on what plant you now have, the amount of cooling water available and the cost of fuel and labor as compared with the cost of installation.

The temperature of steam at a vacuum of 28 in. is 101.5 deg. and it is usually possible, with a good barometric jet condenser, to raise the temperature of the cooling water to within 10 deg. of that of the exhaust steam. If you will look in the data sheet of the April issue, you will find there a chart giving the theoretical cooling water needed per pound of steam for different conditions. For condensing water at 70 deg. and 28-in. vacuum the theoretical amount is 30 lb. of water per pound of steam condensed, and if we assume that there is 10 deg. lost it would give us the same as if the cooling water were 80 deg. or 43 lb. of cooling water per pound of steam.

You will also find in the April issue a discussion of the question of low-pressure turbine as an addition to a steam plant, and in one of the illustrations there you will find curves given showing the steam consumption for low-pressure turbines at different vacuums. A 500-kw. at 28 in. vacuum would take about 29 lb. of steam per kilowatt hour and for 500 kw. this would call for 14,500 lb. of steam an hour total.

At 45 lb. of cooling water per pound of steam this would necessitate 580,000 lb. of cooling water an hour or 92,800 cu. ft. per hour. A similar computation taken for compound condensing engines will give you the cooling water required per hour for such a unit.

It takes a larger condenser plant and more cooling water to run a turbine at good efficiency than it does to run a reciprocating engine, but, on the other hand, the turbine taken alone gives a better account of itself than does the engine taken alone.

The ideal combination is the reciprocating engine for the high-pressure part of the plant and the turbine for the low-pressure. This involves, of course, the use of 2 generators and somewhat increases the cost over that of a straight turbine plant. It is possible that you might be able to add a low-pressure turbine which would take the steam from your present reciprocating engines and by adding condenser equipment to give you a low vacuum, if you have sufficient cooling water available, that you could get the needed additional power without more boiler capacity than you now have.

Assuming that your present plant has 1000 kw. of engine units and that this is developed at a rate of 20 lb. per kilowatt hour, which is good performance for an engine plant, you would be using 20,000 lb. of steam at 26 in. vacuum, which would call for about 420,000 lb. of cooling water an hour. If you now add

a 500-kw. low-pressure turbine you would be able to develop 1500 kw. at a steam consumption of 16 lb. or 24,000 lb. of steam total per hour at a 28-in. vacuum, and this would call for 1,055,000 lb. of cooling water an hour. It will call for the handling of this extra cooling water but will require the making of only 4000 lb. of steam an hour additional in order to get the 500 kw. extra output.

Examination Questions

WHY do we give a valve lead?

2. What is the difference between a force pump and a suction pump?

3. How would you equalize a piston if the rod was keyed into the crosshead?

4. Why is a condenser attached to an engine?

5. If the eccentric would slip on the shaft, how would you alter it, if you did not care to stop before the day was over?

6. What is the object of a bridge wall?

7. What is the difference between a common slide valve engine and a cross-compound?

8. What is the difference between a brace and a stay bolt?

9. What is a fuse plug and where is it placed in a boiler?

10. What creates a draft?

11. In what position would you have your engine if keying up?

12. If your pump did not work and had plenty of water, what would be the cause? O. B.

A. A valve is given lead in order that the pressure in the cylinder may be up to boiler pressure at the time that the piston starts to move forward.

2. A force pump is one which draws the water but a short distance by suction, then forces it upward by driving the plunger down into the pump cylinder. In the suction pump the pump is placed near where the water is to be delivered and draws up the water from below, by lifting it in a bucket or piston. This bucket runs tight in the pump cylinder.

3. To equalize the distance of a piston from the 2 heads with a rod keyed into the crosshead, it would probably be necessary to change the length of the connecting rod by the use of proper shims. If the space were too great in the head end of the cylinder, shims would be changed around the boxes in the connecting rod so as to lengthen the distance; that is, the shims would be put in between the cross-head and the crankpin. If, on the other hand, the space were too large in the crank end of the cylinder, shims would be taken out between the crosshead and crankpin and put in outside the boxes. This change might be made at either or both ends of the connecting rod, according to the construction.

4. A condenser is attached to an engine to lower the back pressure and temperature. The possible efficiency of an engine depends upon the ratio of the difference between the temperature of the steam as it enters the cylinder and as it leaves, to the absolute temperature as the steam enters. In order to make this ratio larger and, therefore, increase the possible efficiency, the difference between the initial and the exhaust temperature must be increased, and this can best be done by lowering the back pressure.

5. It would not be advisable to try to set the eccentric shaft with the engine running. If the slip were not very great, the chances are that any effort to remedy it with the engine running would only make matters worse. If the slip were sufficient to interfere seriously with the operation of the engine, the short time required to shut down and reset would cause less trouble and less damage than the probable accidents which would occur from trying to set with the engine in motion.

In order to slip, an eccentric must have been fastened with set screws, for if keyed in place it would only slip by the shearing off of the key. Trying to twist an eccentric back into position after the set screw had slipped would be a dangerous proceeding and probably would not give any permanent relief, as if it slipped once it would slip again.

6. The bridge wall is primarily to hold the fire from dropping off the end of the grate into the combustion chamber. Sometimes it is made hollow and the air is passed through it before going under the grate, thus utilizing it as a pre-heater for the air. Sometimes also it has been made higher than necessary to hold the fuel, and has been provided with passages so as to insure complete mixture of air admitted above the fire with the unburned gases, thus assisting to complete the combustion.

7. A slide valve engine may be made cross compound. The distinction is between the simple engine and the compound, the simple being an engine which has one cylinder for the expansion of steam, and the compound an engine having 2 cylinders, the steam expanding from the high-pressure into the low-pressure, and from there going to exhaust. Either the simple engine or the compound engine may be made with a common slide valve, or a gridiron valve, or a Corliss valve, or any other type.

8. A brace is used to hold the head or crown sheet of a boiler against the internal pressure, while a staybolt is used usually to hold the sides of the firebox or sometimes the crown sheet from collapsing inwards on account of the boiler pressure. Sometimes, however, the staybolt is used to strengthen the plates. In either case the bolt is a single straight piece threaded throughout its length, which passes from one plate to another and is beaded over or riveted after screwing into position. The brace is carried either from one head through to the other, or is carried from the shell to the head or from the shell to the crown sheet, and is usually fastened in position by rivets.

9. The fuse plug is a screw plug filled with an alloy which melts at low temperature and is placed in the boiler shell at about the level of the upper tubes or at the level of the sheets, a little below where the water line ought to stand. The object is that if the water line gets below a safe point the fuse plug will melt out and let the water out of the boiler onto the fire, thus causing the formation of a large amount of steam and calling the engineer's attention to the fact that the boiler is in danger of burning. The location depends on the type of boiler and is best summarized in the Massachusetts Board of Boiler Rules, which can be obtained by writing to the Board of Boiler Inspectors, State House, Boston, Mass., and enclosing 10 cents for postage.

10. A draft is created by the difference in weight between the gases inside the chimney and outside. A column of equal area outside the chimney is cold and, therefore, weighs more than the column inside and tends to fall into the furnace and push up the column of light hot gases. Draft depends, of course, on the difference in weight between the 2 columns, and this in turn depends on the height of the column and the difference in temperatures between the inside and the outside gases.

11. In keying up an engine, by which probably you mean keying up the crosshead and crankpin bear-

ings, set it as nearly as possible with the crank and connecting rod at right angles. The reason for this is that in this position it is generally easier to get at the keys than in any other and it is also easier, if the engine be a small one, to test for play in the bearings. As a matter of fact, keying up on large engines may be done in almost any position because the play cannot be detected anyway, on account of the weight of the moving parts.

12. The cause of a pump not working when it had plenty of water might be found in a dozen different places. It might be that the foot valve was leaky, or that the piston was leaky, or that the pump was air-bound, or, if pumping hot water, that it was steam bound, or that the suction valves of the pump were leaky, or that the steam piston was leaking, or several other places which have latent possibilities for making trouble. The question is too general to admit of any definite answer.

Cards From a Marine Engine

HEREWITH is a set of cards taken from a triple-expansion engine, size 24, 39 and 59-in. cylinders, and 48-in. stroke. I would like to know the mean effective pressure on each cylinder and the error of each card. The sizes of springs used were: 80 lb. on the high-pressure, 40-lb. on the intermediate, and 16-lb. on the low-pressure cylinder. The high-pressure cylinder has a piston valve and the intermediate and low-pressure cylinders have 4-posted slide valves. The cards were taken at sea, Jan. 8, 1911. K.

A. The calculated horsepowers are as follows: High-pressure, card 1, 586.6; high-pressure, card 2,

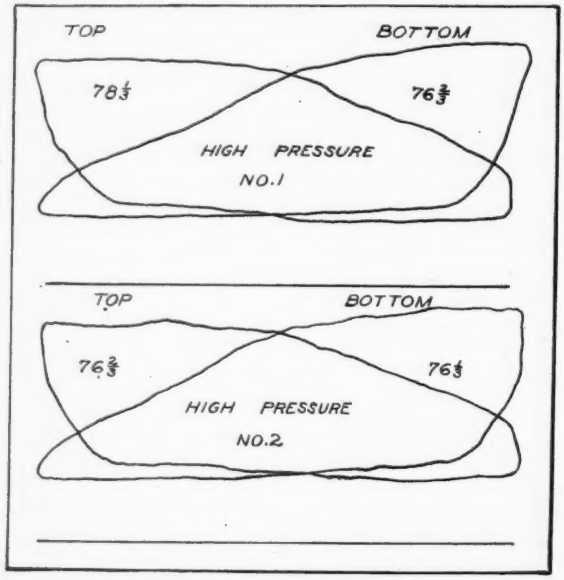


FIG. 1. CARDS FROM THE HIGH-PRESSURE CYLINDERS

587.5; intermediate, 568; low-pressure, 525.6. The mean effective pressures as calculated by the use of the planimeter are marked on the cards.

Your engine is pretty well overloaded, as evidenced by the cutoff being very late in all 3 cylinders and the valve action is slow, i. e., it does not cut off sharp. This may be, however, a characteristic of the valve mechanism, as you do not state the style of engine.

Compression is high for the speed at which you are running, and the falling off in the steam lines after admission indicates that the ports are too small or valves do not open wide enough, or else the steam pipes are too small so that the flow of steam is not free.

There is in a triple-expansion engine a certain amount of reaction between cylinders and receivers, which makes it difficult to figure exactly what is happening, but starting first with the high-pressure card, the top and steam valve seems to be leaking, for there is a considerable dropping off in pressure in the cylinder, even before the exhaust opens. Admission is late, for the pressure does not come up sharply to steam pressure at the beginning of the stroke. The same thing is true in the bottom end and compression on the top end is too high.

There is a peculiar rise in the back pressure line all the way through the exhaust stroke, but this may be due to compression in the receiver, which seems evident, particularly as the same effect is noticeable on the intermediate cards. The intermediate pistons and valves seem to be reasonably tight but the compression on the

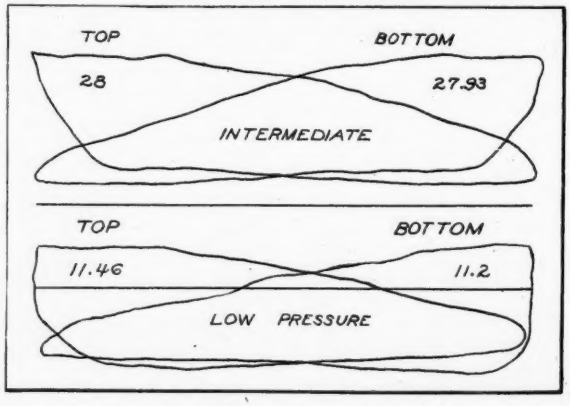


FIG. 2. CARDS FROM THE INTERMEDIATE AND LOW-PRESSURE CYLINDERS

top end is high. There is also the same falling off in steam pressure but in this case it may be due to a small receiver.

In the low-pressure card there is drop in exhaust pressure all the way through, and this ought not to be the case, because in exhausting into the condenser the back pressure ought to drop nearly to condenser pressure at the beginning of the exhaust stroke and to remain there all the way to compression. The drop in steam line here may be due to a small second receiver.

The perfectly straight line at the end of the card in the low-pressure cylinder makes it look as if the indicator was striking on stops at the ends of the stroke. Admission here is prompt and sharp, but this might show up differently if a full length card were drawn.

Turbo-Generator and Safety Valve

WHAT is a turbo-generator? Name and describe types in common use.

2. How would you determine the area of a safety-valve, first a lever, second a pop, on a horizontal tubular boiler, also on a water-tube boiler?

3. How would you determine at what pressure a lever valve was set to blow, also a pop valve?

4. To what defect is a safety valve most liable?

5. Under what condition should a safety valve be set? G. S.

A. A turbo-generator is a combination of steam turbine and electric generator. This may be either di-

rect current generator or alternating current, according to the service for which the unit is intended. As to the types of turbine you will find these described in the April issue. The generators are much the same as any other electric generators except that on account of the high speed they are either 2 or 4-pole machines.

2. The area needed for safety valve, either lever or pop, depends on the horsepower of the boiler, i.e., on the amount of steam that the boiler can make at its highest output. All safety valve rules are based on this, but some of them are figured on the rule of thumb assumption as to how much steam a boiler will make, while others are figured on scientific calculation of this amount of steam.

The safety valve should have capacity for the steam generated, not only at normal rating, but when forced. The matter has been much discussed and perhaps the best data at present are, assuming a boiler horsepower to mean the evaporation of 30 lb. of steam per hour and that a boiler may be forced to twice its normal rating, figure the total weight of steam, then find the cubic feet of a pound of steam at the given boiler pressure and see how many cubic feet must be discharged.

The lift on a well designed valve should be about 1/33 the diameter. Tests have shown that for a 1-in. valve this would be 0.03, for a 2-in. valve 0.06, for 3-in. valve 0.09, for 4-in. valve 0.13, 5-in. valve 0.15, 6-in. valve 0.19. The lift times the circumference gives the area through which the steam can flow and the amount of out-flow would be found with sufficient accuracy from Napier's formula: Pounds of steam discharged per hour equals constant times the discharge area in square inches, times the pressure in pounds per square inch, the constant being 47.5 as given by experiment.

For a 45-deg. seat this works down to: the diameter required in inches equals 0.0095 times the pounds evaporated per hour, divided by the lift in inches, times the absolute pressure; or the discharge of a given safety valve in pounds per hour equals 105 times the lift in inches times the pounds pressure absolute, times the diameter in inches.

If the valve seat is flat instead of 45 degrees, the constant in the expression for diameter becomes 0.0067, and in the expression for pounds discharge becomes 149.

The pressure at which the lever safety valve will blow is figured by the method that has been given repeatedly in publications and pocket books. Multiply the weight of the ball by the distance from its suspension to the fulcrum. Multiply the weight of the lever by the distance from its center of gravity to the fulcrum. Multiply the weight of the valve and stem by the distance from the point of attachment of the stem to the fulcrum. Add these 3 products together and divide by the distance of the valve stem from the fulcrum. This gives the total pressure required to lift the valve. Divide this by the area of the valve disk and the boiler pressure required to lift the valve will be the answer.

3. On a pop safety valve the only way to know at what pressure it will open is by test, as the strength of the spring cannot be figured accurately beforehand without knowing exactly the kind of material from which the spring is made.

4. The most likely defect of a safety valve is sticking to the seat. This is, of course, overcome by seeing that the safety valve is lifted either by hand or by steam pressure every day.

5. The safety valve should be set under normal conditions, i.e., it should be arranged so that it will blow off at the desired pressure when it is shifted by steam under pressure and when set in the same position in which it is to be used.

Effect of Manholes on Strength of Boilers

ACCOMPANYING is a sketch of a horizontal return tubular boiler, with a manhole cut in middle course, 11 by 15 in. There is also a hole in the third course, 14 by 18 in., that requires patching. How much does it weaken the plate in the middle course to cut a manhole of the above dimensions? Give methods of calculation.

2. How many rivets, and of what diameter, must be used in patching the hole in Fig. 1 to have the patch equal the strength of the longitudinal joint?

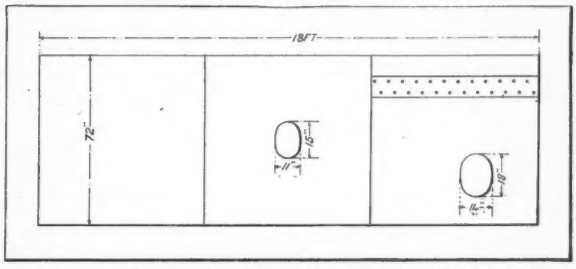


FIG. 1. HORIZONTAL RETURN TUBULAR BOILER WITH MANHOLES

State the best way to drill the rivet holes; i. e., should they be diagonal to the longitudinal joint, or parallel to it? Why?

3. Figure 2 represents a boiler 36 in. in diameter and 9 in. long. The shell strip of 9 in. is ½ in. thick. Both heads are flanged and riveted to the strip, the heads are staybolted to each other and capable of standing 150 lb. per square inch. How much does it weaken this strip to cut a handhole 4 by 8 in. or one 2 by 3 in.? R. W.

A. In cutting a manhole, the weakening will be in proportion to the length of metal removed along the axis of the boiler. In the case of your 11 by 15 man-

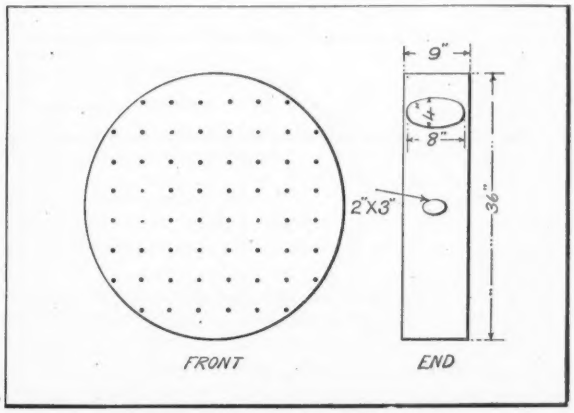


FIG. 2. BOILER WITH HANDHOLES

hole, you are cutting out 11 in. of a 6 ft. sheet, and it will reduce the strength along the line through the manhole as 11 is to 72, or about 1/6. This is, of course, counteracted by putting on a heavy man hole rim riveted to the shell of the boiler.

2. In the case of the 18 by 14-in. patch, the rivets should be put thick enough to permit of calking a

tight joint. This depends, of course, on the thickness of the plate, which I cannot find that you give.

The spacing of the rivets in putting on the patch in order to give strength, would make little difference as to whether it were parallel or diagonal to the longitudinal joint. The point is to get the patch firmly attached to the main plate so that it will get full strength to resist pulling apart along the 14-in. diameter. I should suppose, from what you write, that a double row of rivets, each 13/16 in. in diameter and pitched 3 in. apart in each row, would give you sufficient strength and chance to calk to a tight joint.

3. In regard to your third question, as you have drawn the manhole, the 8-in. diameter would be longitudinal of the sheet and you would have only 1 in. left to prevent the plate from tearing apart along a longitudinal seam. You would, therefore, remove 8/9 of the strength in this direction. Of course, in the construction shown a good share of the ability of the plate to resist tearing would come from its being held by the rivets which attach the heads, but how much this would hold is a thing it would be impossible to figure with any accuracy.

In the case of the 2 by 3-in. handhole, the 3 in. runs parallel to the axis of the cylinder and the reduction in strength would be 3/9 or 1/3 the strength of the plate.

Steam Consumption

HOW many pounds of steam per horsepower per hour are required to run an engine 24 by 48 in., at 60 r.p.m. noncondensing, assuming both cards to be the same as the one herewith, which was taken with a 40-lb. spring?

2. What is the horsepower of this card?

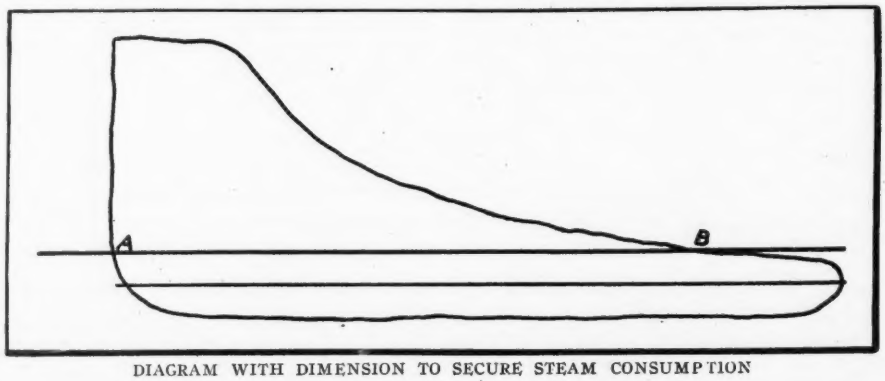


DIAGRAM WITH DIMENSION TO SECURE STEAM CONSUMPTION

3. I have a duplex compound pump, high-pressure cylinder, 14 in.; low pressure, 20 in. How will I have to set the valve on the low-pressure cylinder from the high-pressure?

4. If a compound Corliss engine is employed, how can I set the valves on the low-pressure cylinder from the high-pressure?

5. A boiler is carrying 90 lb. steam pressure and is equipped with a 4-in. pop safety valve which blows at 95 lb. How much will the valve rise, and how much steam will blow out per second? W. K.

A. The way to find the steam consumption is to draw a line parallel to the atmospheric line and intersecting both the expansion and compression curves at points B and A. The distance AB will then represent the volume at the pressure indicated by this line AB of the amount of steam taken by the engine per stroke.

The length AB is 3 25-32 in.; the total length of the card is 4 13-32 in., which represents the total cylinder volume. This cylinder volume we find by multiplying the area of a 2-ft. circle, which is 3.141 sq. ft., by the length of the stroke, giving 12.564 cu. ft. Then the volume represented by AB is to 12.564 as 3 25-32 is to 4 13-32, which gives as the volume of AB 10.782 cu. ft.

The line AB on 40 lb. scale is 7 lb. above the atmospheric. Adding this to 15 lb., the atmospheric pressure, gives 22 lb. absolute as the pressure on the line AB. At this pressure a pound of steam occupies 18.03 cu. ft., so that 10.782 cu. ft., would represent 10.782÷18.03, or 0.5985 lb., which is the steam taken per stroke by the engine. On one end of the cylinder the engine will then take 0.5985×60×60, or 2145 lb. per hour.

2. To get the horsepower of the engine we find the mean effective pressure by the use of the planimeter, which works out to 29½ lb. The horsepower, by the regular rule, is then 29½×4 (the length of the stroke) ×452.4 (the area of the piston in inches) ×60 (the number of revolutions), divided by 33,000, which works out to 97 hp. in one end of the cylinder. Dividing the steam used per hour by the horsepower gives us 22.12 lb. of steam per horsepower per hour.

One thing in your question is puzzling. You say this is a Corliss engine, noncondensing, and yet you say your back pressure line is below the atmospheric line.

3. In regard to the setting of the valves of a duplex compound pump, the low-pressure cylinder is set exactly the same as the high-pressure. Both high and low-pressure cylinders in this style pump take steam full stroke, so that the only setting of the low-pressure valve is to give the low-pressure side as long a stroke as possible without having the piston strike at the ends.

4. In the compound Corliss engine the method of setting low-pressure valves is exactly the same as for setting the high-pressure. The same directions apply in both cases. The only thing that would be changed in any way would be the point of cutoff and this is regulated by the position of the knock-off blocks on the steam valves. Unless these are controlled by the same governor that regulates the high-pressure cutoff, they are usually controlled by a hand-adjusting screw and the cutoff is adjusted to give the desired receiver pressure, shortening the cutoff if the receiver pressure is to be raised, and lengthening it if the receiver pressure is to be lowered.

5. The lift of safety valves varies, as shown by experiment, with the make of valve, but the assumption

of the Massachusetts rule, which is the one most logically worked out, is that the lift is 1-33 the diameter. For a 4-in. valve this gives a lift of 0.13 in. The flow of steam per second is found by the rule:

Multiply the boiler pressure in pounds absolute by the area of outlet, and divide by 70. The area of outlet is found by multiplying the circumference of the valve by the height of the lift. For a 4-in. valve the circumference is 12.56 in., and this multiplied by 0.13 and by 110 and divided by 70 gives 2.57 lb. as the flow per second.

Transformer Troubles

TWO transformers are connected to a 3-phase circuit furnishing current for lighting purposes. The lights do not burn up to the rated candle power. The generator is run at its highest voltage and it is apparent that the transformers are overloaded. Can the candlepower be raised by connecting another transformer with the present ones, so that there would be one for each phase? V. H.

A. The question does not state whether the two transformers are connected V or open delta, or have T connections. It will be assumed, however, that they

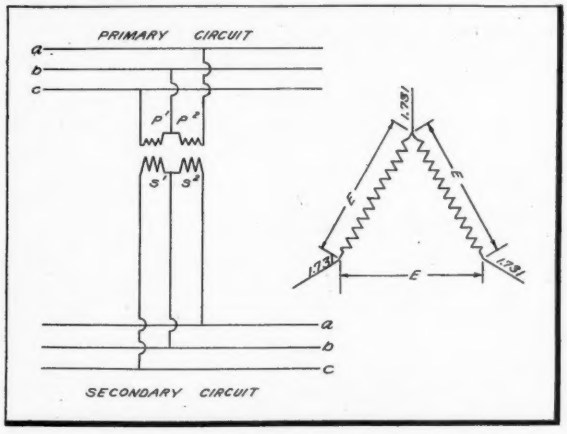


FIG. 1. TWO TRANSFORMERS CONNECTED DELTA OR V ON A THREE-PHASE LINE

have V connections, as shown in Fig. 1. If this is the case, each transformer when in the group has 58 per cent of the group rating. The natural assumption that each transformer should have a kva. (kilovolt-ampere) rating equal to 3 E I÷2=1.5 E I where E= e.m.f. and I=current is not correct, since the transformer voltage equals the line voltage=E, the transformer current equals the line current=1.73 I and the resultant kva. developed in both the primary and the secondary windings is E×1.73 I=1.73 E I, which is 15½ per cent in excess of 1.5 E I. Therefore, for this connection each transformer should have a kva. rating equal to 3 E I÷2×15.5=1.73 E I, which is approximately 58 per cent of the group rating.

In Fig. 2 the transformers are delta-connected and the rating of each transformer is one-third of the group rating or expressed in detail, the kva. rating is equal to 3 E I÷3=E I, since the transformer current equals the line current divided by 1.73=I and the resultant kva. rating developed in both the primary and secondary windings is therefore E×I=E I.

To analyze the situation more fully, let it be assumed that there are three transformers connected in delta and equally loaded until each carries 100 amperes. There will be 173 amperes in each external circuit wire. If one transformer is removed and the remaining two continue to supply 173 amperes to each external circuit wire, they must carry 173 amperes, since each one is now in series with an external circuit, as shown in Fig. 1. Assume, as in the case given, (Fig. 1), that the transformers are carrying 173 amperes, then by adding another transformer to form a delta connection, Fig. 2, each transformer will only carry 100 amperes, thus reducing the load on the 2 original transformers 73 amperes, which should relieve the trouble caused by low voltage at the lamps.

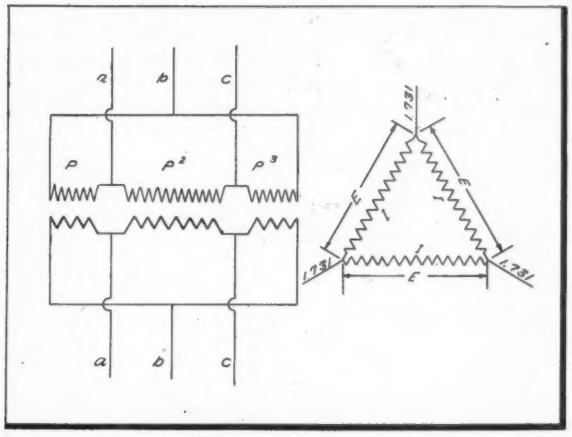


FIG. 2. THREE TRANSFORMERS CONNECTED DELTA ON A THREE-PHASE LINE

Temperature of Ammonia in Expansion Coils

ON the ammonia circuit, after the ammonia leaves the receiver and enters the expansion valves and expands through the expansion coils, does it get hot? I am in a dispute over this question. I claim that the ammonia, after it passes through the expansion valves and enters the expansion coil, is cooler than the brine or it would not take up the heat from the brine. The other man claims that as it passes through the expansion coils it is as high as 100 deg. and that it takes up the heat from the brine as it passes through the expansion coils. I. D. S.

A. Ammonia, in passing to the expansion coils, is usually at a pressure of 140 to 150 lb. gage. As it expands in the coils it goes to a much lower temperature. At this pressure the temperature will be about 84 deg. F. When it passes through the expansion valve, it is usually reduced to about 30 to 40 lb. gage pressure and at 40 lb. the temperature would be 26 deg. F.

It would thus absorb some heat by direct conduction from the brine, but the main absorption of heat is due to the evaporation of the ammonia. A pound of ammonia evaporating at 40 lb. pressure will take up 540 heat units. These come from the brine and, therefore, cool the brine by just that amount.

It might be possible for the ammonia to take up heat even if it were at the same temperature as the brine, on account of the evaporation, but as a rule the ammonia, when entering the expansion coil, will be at a lower temperature than brine. This all depends upon the pressure maintained in the expansion coil and the temperature at which the brine is circulated.

GREASE FOR WIRE ropes may be made by melting together 10 parts tar, 10 parts pitch, 2½ parts resin and 2½ parts tallow.

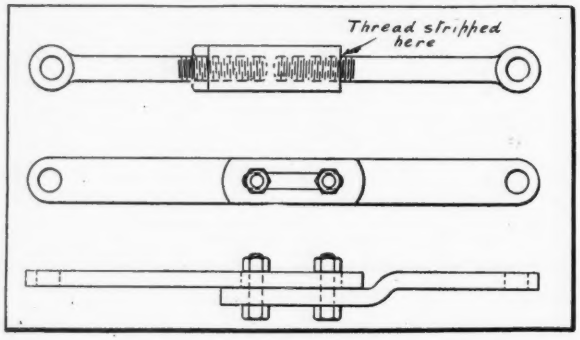
SUCCESSFUL KINKS

FOR SAVING TIME, WORK AND TROUBLE

Repair to Pump Rod

JUST at the time when the pump was most wanted, the valve rod on a boiler feed pump suddenly gave way. One end of the rod had no locknut on, and this was the end that gave out, through the thread stripping.

A temporary rod was made up, as per sketch, in a very short time, with 2 pieces of best iron 5/8 in. by 1½ in., and slotted so as to get a correct valve setting; when I had got this, I turned a new rod solid right through, which is cheaper than making it in 2 parts. The tem-

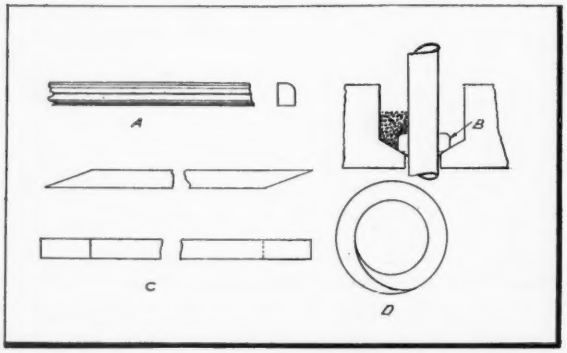


TEMPORARY PUMP ROD

porary rod comes in very handy when other pumps go wrong. I may say I put spring washers under the nuts on the temporary rod, and they never worked loose, although the pump is at work practically day and night.

Metallic Packing Kink

OF late years many engineers are using metallic packing on the piston rods of the engines and pumps in their charge. Most metallic packing, when it works successfully, lasts longer, and requires less time and labor than fibrous packings. Some engineers, however, have discontinued the use of metallic packing



KINK TO PREVENT METALLIC PACKING WORKING INTO THE CYLINDER

because of the difficulty experienced in keeping it from working through the space between the stuffing box and the rod into the cylinder.

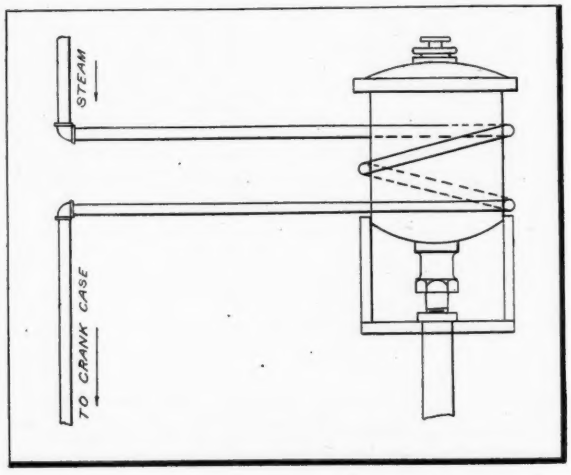
To overcome this difficulty a copper ring made of a piece of wire is used in the back end of the stuffing box. A piece of copper wire is not satisfactory as a bushing, as it will not follow up the wear of the rod and leaves a space through which the packing may work out.

A small copper bar, with one corner rounded off, as shown at A in the figure, will work better. The pressure on the curved surface B of the ring will cause it to stay close to the piston rod and thus prevent any leakage of packing into the cylinder. The bar should be annealed and the ends filed down as shown at C, so that they will fit together as shown at D. The ends can then slip a little as the wear is taken up around the rod, while if the ends were left square, the ring would not follow up the wear of the rod.

R. L. Rayburn.

Warming Oil in Cups

WE use crank case oil in the main bearings of the engine which is a Westinghouse automatic compound. During cold weather we were bothered a great deal by the oil not feeding properly. The cup on the flywheel end being the worse. The one on the governor end was not so bad as the oil would keep



STEAM COIL FOR WARMING COLD OIL CUP

warm enough with the heat transmitted from the engine to flow properly, but the cold air circulated around the cup on the flywheel end and kept that one cold.

We boxed it up all we could, but it still acted badly so we run a ¼-in. pipe from the steam main to the cup, then made a coil of pipe to fit close around the cup and from there piped it into the crank case. When getting ready to start up, we turn the steam into the pipe around the cup and the oil is soon warm enough to flow freely. The idea is illustrated by the sketch.

Bee's Wax as Commutator Lubricant

IN the station here is a Brush arc machine that gave a lot of trouble with cutting the brushes and commutator. We used a stick with a rag on it soaked in oil, but that would not last long as we had to keep a long spark on machine to keep it from flashing over,

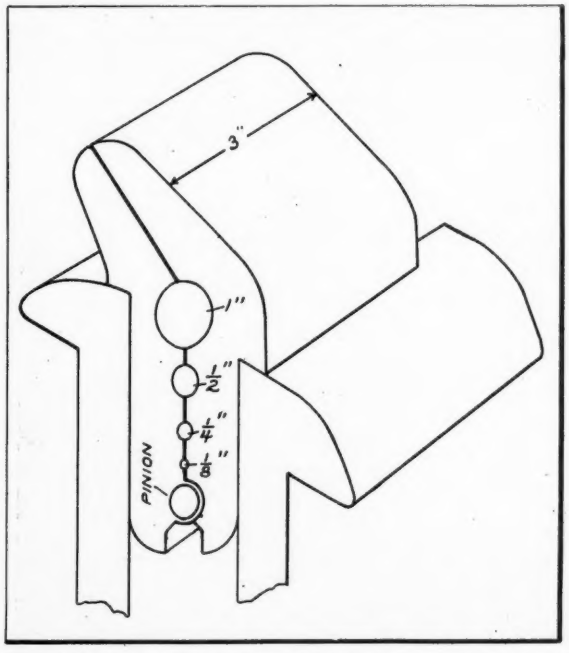
and the long spark would soon burn the oil off and the brushes would get to cutting again.

In changing over the station the arc machine was coupled direct to a motor, which ran 600 r. p. m. while the arc machine had run only 500 r. p. m. This running it faster gave a good deal more trouble.

After trying all kinds of oil and grease, I thought of trying bee's wax. The machine ran better the first time it was tried, and before the next run I sandpapered the commutator and trimmed the brushes and it hasn't given a bit of trouble since. In using the wax hold it on the commutator a little while after starting up. It will soon put on a good glossy finish such as engineers like to see. Leon L. Pollard.

A Convenient Vise Accessory

HEREWITH is illustrated a device which is of great convenience in working about a plant. Frequently it happens that it is desirable to put a bevel edge on a strip of metal, and it is difficult, if this strip be held in a vise, to file it on a slant, and even more difficult if it be held in the hand. The device shown grips the metal at 45 deg. so that putting on a bevel is simply a matter of holding the file horizontal. The



VISE ACCESSORY FOR BEVELING STRIPS OR HOLDING SMALL PIPE

device may also be used to hold small sizes of pipe without crushing when it is desired to cut threads. The dimensions can be varied to suit conditions. The actual size as originally made was with the length of the lower jaw on the bevel 1¾ in., the thickness of the jaw on the stem ¾ in., the holes the right size for different pipes, as shown, and the width of the device 3 in.

Packing for Piston-Rod

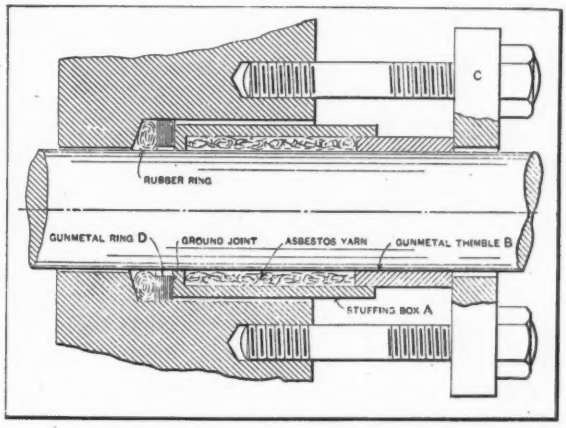
IN an engine used in driving a paper-making machine the piston-rod packing was a constant source of annoyance and trouble. The engine, which was of the horizontal type, had been running 24 hr. a day for 17 yr. without necessitating the reboring of the liner. No doubt the wear on the bottom of the liner and piston caused a certain want of alignment with the guides, thus producing a slight up and down movement of the rod, which helped to cause this trouble.

It will also be seen from the accompanying illustration that the stuffing-box is very shallow, so that very little packing could be introduced. The constant effort to keep the gland comparatively tight with any packing hitherto tried resulted in heated and scored piston rods.

About 2 yr. ago the writer designed and applied the device shown in the illustration. Since then this has been running 24 hr. a day without any attention, except that about a year ago a little additional asbestos yarn was inserted. Steam-tightness is secured with only a very slight tension on the screws, and the rod is smooth and shows scarcely any wear.

Before devising this arrangement some form of metallic packing was thought of, but as the steam is very wet it was feared that this might not be successful. A feature of the device is its simplicity and the fact that it can be applied to an engine without any alteration to stuffingbox or gland studs.

Referring to the illustration: A represents the floating stuffingbox made of gunmetal, which is a very loose fit in the old stuffingbox, so as to allow freedom



PACKING FOR A PISTON ROD STUFFING BOX

of alignment. The inner flange of this is a sliding fit on the rod. To obtain sufficient strength in the walls of the box, only ¼ in. was left all around for the packing, which was asbestos yarn rubbed with graphite. A gunmetal thimble B, which is a sliding fit on the rod and also in the stuffingbox, compresses the packing when pressed forward by screwing up the gland nuts.

C is a cast-iron plate bearing on the end of the thimble, with the central hole large enough to clear the rod. A gunmetal ring, D, which is drilled to clear the piston-rod, rests on a ring of ⅜-in. round rubber placed in the bottom of the old box. The faces of the ring and the new box, which are in contact, are carefully faced true, and afterward ground together to make a steam-tight joint.—Machinery.

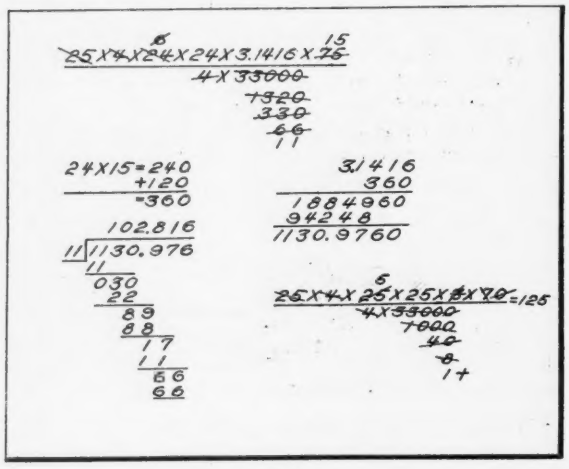
INSULATION OF HEATED SURFACES should be considered an investment whereby the discomfort of the engine room can be eliminated and the heat thus saved (no small amount either) turned into useful energy.

AN ERROR IN CANCELLATION

WE have received from John Seethoff, Jr., of New Salem, N. Dak., a letter, as follows, calling attention to an error in the December issue which is likely to cause confusion:

"I wish to call attention to a process of cancellation on page 841, in the December number of Practical Engineer. In top paragraph of left-hand column, the contributor says, 'The factor 4 will cancel into 24, leaving 6, and into 1320, leaving 335,' etc. Now, if the contributor means that 4 is contained 335 times in 1320, I think he is off a few points.

"As to the contributor's method of making a rough check to prove the decimal point's position, I think he is way off. Let us look in the tables of horsepower for 1 lb. Mean Effective Pressure in the Data Sheet. Now bear in mind that our contributor is figuring one end of the cylinder only, which gives us a piston speed



CHECKING CANCELLATION

of 300 ft. Therefore a 24-in. cylinder gives us 4.113 hp. for 1 lb. m.e.p. Since he is figuring 25 lb. m.e.p. we will multiply 4.113 by 25, which gives us 102.825 as the horsepower. His method of cancellation, when accurately worked out, gives us the horsepower as 102.816, which shows that his way of proving the decimal point position does not work in this case.

"The contributor also says, 'The experienced engineer will know from the dimensions and data given whether this is about right for the horsepower or not, but for the novice there might be a delightful state of uncertainty whether it ought to be 87 or 872 hp.,' etc. He is either trying to catch someone or a little ignorant on the subject himself."

Mr. Seethoff is quite correct in his criticism of the inaccuracy of the work. The cancellation of 4 into 1320 should have given 330 and the cancellation of 5 into this would have given 66. As shown in the example, as worked out herewith, it is now possible to cancel 6 into 24 in the numerator and into 66 in the denominator giving 11. Then multiply 24 by 15, which gives 240 plus 120, or 360. The multiplication of 360 by 3.1416 is shown, giving 1130.976, and this divided by 11 gives 102.816 as Mr. Seethoff states.

Going now to the approximate cancellation to determine decimal point: Take in the numerator, 25 and 4 as they stand; take 25 in place of 24 in each case and drop the decimal places after 3; use 70 in place of 75, and, in the denominator, use 30,000. Cancel 0 of 70 with a 0 in the denominator. 4 cancels 4, and 3 cancels into 3000, leaving 1000. We then cancel 25 into 1000, leaving 40 and 5 into 25 and into 40 leaves 5 in the numerator and 8 in the denominator. The 8 will cancel approximately with the 7 of the 70, leaving the numerator 5×25, which is 125, and locates the decimal point as being correct in the problem as worked out by long division.

It is needless to say that the editors of Practical Engineer regret the errors that crept into this problem and trust that the mistake has not caused confusion to its readers.

INCREASING THE CAPACITY OF A GAS SUPPLY SYSTEM

IN RECENT years considerable progress has been made in the high-pressure system of gas distribution. The gas is generated the same as in the low-pressure system, and then by compressors its pressure is raised from about 4 in. of water (1/7 lb. per sq. in.) to 10 to 40 lb. and delivered to the mains. No district holders are required.

Several companies are supplying high-pressure gas in the United States and in England, a particularly interesting installation being that of the New York & Queens Gas Co., Flushing, L. I., which shows how a low-pressure system can be cheaply and efficiently transformed into a high-pressure system. For the information contained in the following we are indebted to M. H. Spear, secretary and manager of the company.

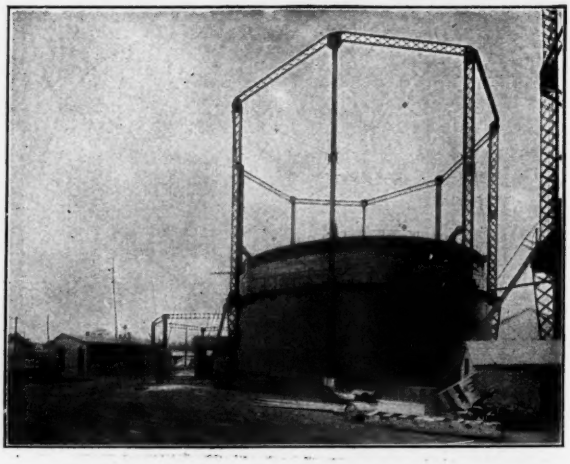


FIG. I. COMPRESSOR HOUSE NEAR HOLDER AT GAS WORKS

A large and growing district is served by the New York & Queens Gas Co., and the demands on equipment had reached such a point that it was necessary either to lay more or larger distributing mains or to install another district holder, or by some other means increase the pressure to supply the distant consumers. A large drop in pressure was shown by gage readings, for at the works there was a 5-in. water pressure, while at Bayside, 7 miles away, there was only 1½ in.

As the cost of compressors was small compared to that of a holder it was decided to install 4 miles of high-pressure main and deliver the gas at 3½ in. into the low-pressure on the line feeding Bayside so that it would increase the pressure both ways.

A small compressor house, Fig. 1, was built at the works and 2 Laidlaw-Dun-Gordon duplex steam-driven

gas compressors, Fig 2, were installed. The larger one has 12-in. steam and 16-in. gas cylinders with a stroke of 12 in., uses steam at about 100 lb. and compresses the gas to 50 lb., while the smaller compressor has 8-in. steam and 14-in. gas cylinders, with an 8-in. stroke.

The compressors are connected so that either can be run independently of the other or both at the same time. The small one is generally in service during the day when the load is comparatively light, and the large one from 5 o'clock in the afternoon until 10 at night, or, should the load be exceptionally heavy, both can be used.

Gas enters the compressors at a pressure of 5 in. of water and is discharged into the mains at 30 lb. per sq. in. at the rate of 40,000 cu. ft. an hr. Before entering the mains it passes through controlling and check valves, the latter preventing the gas from returning to the compressors.

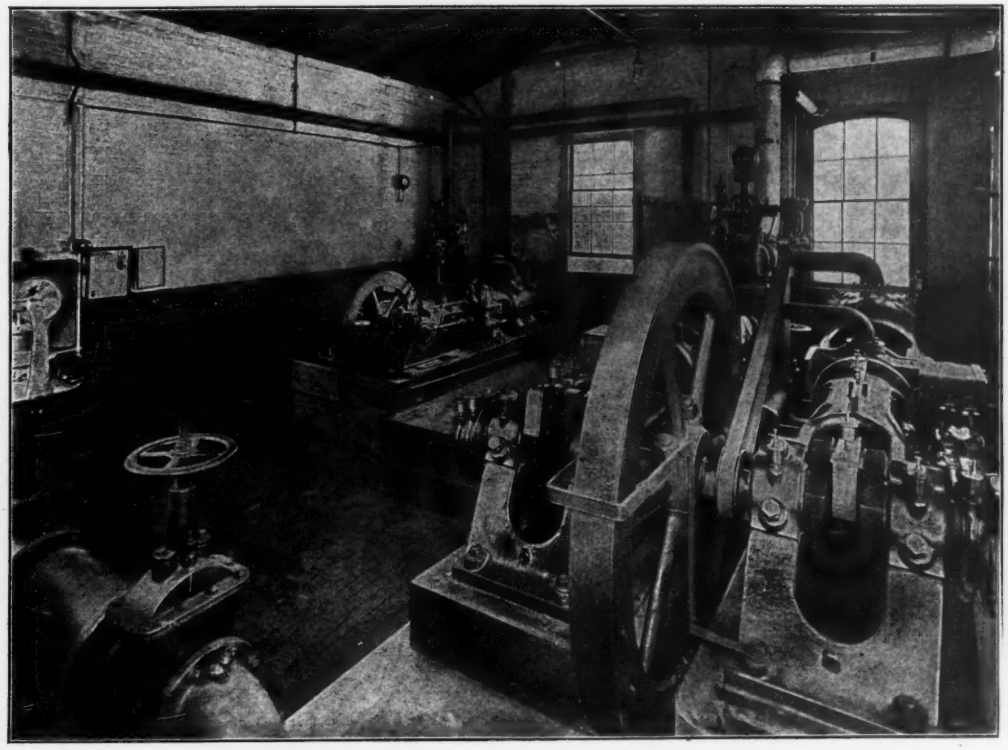


FIG. 2. LAIDLAW-DUN-GORDON GAS COMPRESSOR AS INSTALLED

The distributing system comprises 4 miles of high-pressure mains and 84 miles of low. The former are of 4-in. wrought-iron pipe having recessed screwed couplings with the threads covered with red lead and shellac before making up. Every 400 ft. an expansion coupling is inserted and at every 1000 ft. a gate valve. The fittings were furnished by the Dresser Mfg. Co., Bradford, Pa., and the valves were made specially by the Eddy Valve Co., Waterford, N. Y., and the Ludlow Valve Mfg. Co., Troy, N. Y., as ordinary valves are not gas tight at high pressure.

At the end of the 4 miles the 4-in. line is connected to a 20-in. line that is part of the low pressure-system. Gas is introduced into the latter through 2 Reynolds regulators set in a manhole in the street. From the high-pressure mains, consumers are fed through service pipes, in each of which before entering a house is a regulator for reducing the pressure. In the low-pressure part of the system no regulators are required, the usual cocks only being fitted. The compressor plant and the high pressure system have given perfect satisfaction since their installation.

THE POWER HOUSE extension of the New York Edison Co. will eventually have 6 Stirling boilers each having 23,650 square feet of heating surface. These are undoubtedly the largest single boiler units ever built. Of the 3 units already installed, 2 are equipped with Taylor stokers and the third with an over-feed stoker. The great size of these units is shown by the fact that a single boiler requires 2 13-retort Taylor stokers or 4 stokers of the over-feed type. These units have been thoroughly tested out by 6 24-hour tests on each type of stoker. Such long tests ordinarily require a considerable period, but in the case of the underfeed gravity stoker with no moving parts in the furnace the 6 tests were completed within 10 days.

Dr. Jacobus felt that the tests on the Taylor stoker fired boilers might be subject to question unless they were of such duration as to eliminate all possible chance of error. For this reason the tests lasted more than 24 hours. The test data has not been finally checked and made public, but approximate results are now available. The point of maximum efficiency for the overfeed type was at 80 per cent of boiler rating, and on the Taylor stoker, 120 per cent. The engineers stated that in these tests there was not more than 10 per cent difference between the maximum and minimum efficiency when the Taylor stokers were operated from 80 per cent of rating to 227 per cent of rating.

TO OFFSET THE HEAT lost from a bare 4-in. pipe line, 300 ft. long, carrying steam at 125 lb. pressure with the temperature of the air at 90 deg. F., would require the consumption of 105 tons of coal a year.

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THE POWER FACTOR

The power factor, which exists only in connection with alternating current apparatus, is the ratio between the apparent power in the circuit, volts multiplied by amperes and the real power and is always unity or a fraction thereof. When an alternating current circuit contains inductance the current lags behind the e.m.f. and when it contains capacity the current rises ahead of the e.m.f.; in each case the current and the e.m.f. reach their maximum values at different instants and the product of the e.m.f. and current at any instant is less than it would be if the 2 were in phase with each other.

If the e.m.f. and current be measured separately, the voltmeter and ammeter will give individual mean effective values. If they are measured by a wattmeter, the instrument indicates their combined power effect, not the product of their effective values which occur at different instants, consequently the wattmeter indications will be less than the product of the separate voltmeter and ammeter readings. The relation of the actual power to this product of separate readings is the power factor in the circuit. It may be expressed in the formula in the following manner:

Power factor = Watts ÷ (amperes × volts).

This has given rise to 2 methods of rating electrical apparatus, one on the basis of watts and kilowatts and the other on the basis of volt-amperes or kilovolt-amperes (kva.). The former represents the actual power usually in kilowatts and the latter the apparent power usually in kva. generated, transmitted or used by the apparatus. The latter, or kva. rating, is coming into more general use since it represents more adequately the voltage and current conditions to which the apparatus is subjected.

CRACKED CONCRETE CHIMNEYS

IN a report dealing with the cracked concrete stack of an English manufacturing plant, Sanford E. Thompson discusses conditions and some possible remedies which are of interest to those who may encounter like conditions. In this particular case of the London chimney, the structure had been put up on the dry-mix plan that was in vogue some years ago. The lower third of the stack was of greater diameter than the upper portion, and in the region of the offset, and above it, there were many long vertical cracks. The internal temperature of the stack was pretty evenly maintained throughout the year by the usual operation of the power plant, and there was some leakage through the cracks from the outside. The main concern of the owners, however, was as to the stability of the stack.

Danger from shearing stresses was considered very remote, since such stresses would not reach a critical point until long vertical cracks had formed on opposite sides of the chimney; and even then, an adequate amount of horizontal reinforcement would prevent the

disruption of the stack. Corrosion and consequent weakening of the reinforcing steel was considered the point of most danger, the probability of this being rather large in case of concrete mixed so dry that it did not make a perfect bond with the reinforcement. With wet-mixed concrete, says Mr. Thompson's report, the reinforcing steel is usually covered with a film of cement which will for a long time prevent corrosion of the steel by gases and moisture making their way in through the cracks.

As to remedies, the placing of a fire-brick lining was considered undesirable; such a lining would protect the concrete of the stack to some extent against the heat, but as good concrete easily resists a steady temperature of 600 or 700 deg. F., there was no need of a lining on this score. Moreover, it was considered that the presence of the lining might be mischievous through the new expansion strains which it might transmit to the concrete structure.

Repair by placing a shell of new concrete on the outside of the stack was considered by Mr. Thompson much the best course to follow. It is possible in building such a reinforcing shell, to shut off all access of atmospheric gases and moisture to the reinforcing members of the original structure, and to use reinforcing steel in such a way as to make good the weaknesses that have developed in the original structure owing to the cracks, or to a presumption of an insufficient bonding of the reinforcement due to too dry a mix.

PROTECTION OF INFLAMMABLE LIQUIDS

(NEW METHOD USED IN EUROPE FOR KEEPING AIR AWAY FROM THEM)

By Francis G. Wickware

PROTECTION of plants operated by internal-combustion engines against the special fire hazard introduced by the highly inflammable and explosive nature of liquid fuels demands the most careful and rigorous precautions in methods of storage and handling. Inspired by recent benzine explosions in European cities, which involved in all cases large property loss and in some loss of life, R. Kanoldt has contributed to the Bavarian Section of the Verein Deutscher Ingenieure, a summary of the measures necessary for the highest practicable security. The dangerous glass containers still in common use in small plants should be replaced by iron receptacles, with emptying and filling openings provided with fusible plugs and brass wire screens of fine mesh, on the principle of the Davy safety lamp. In more extensive plants, air should be absolutely excluded from the fuel receptacles, by admission, as the fuel is drawn off, of carbon dioxide, nitrogen, or other inert gas, or, when the nature of the fuel will permit, of water or other neutral liquid. As this method is ordinarily practiced, however, the security is more apparent than real. Unless the apparatus is designed to ensure admission of inert gas or neutral liquid instead of air to the fuel container under all possible conditions, including rupture of the gas or liquid supply pipes, the method offers scant protection.

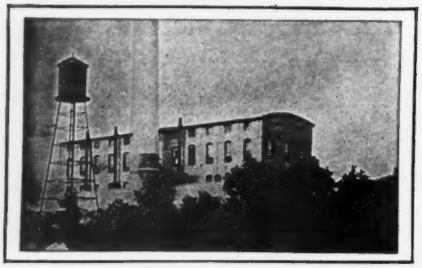
For absolute security, in Herr Kanoldt's opinion, the fuel container should be placed underground, and provided with diffusion guards to prevent entrance of air under any conditions of damage or destruction of the piping or other parts of the apparatus. The whole equipment should be "rupture proof," to the extent of absolutely preventing the escape of liquid fuel in case of damage to the gas or fuel-distributing pipes, the valves, or any other part of the apparatus, through the agency of heat, cold, fire, or internal or external mechanical forces. The nearest approach to perfection he finds in the Martini-Huneke storage and distribution system, which provides efficient safeguards against the diffusion of inflammable gases and the rupture of the fuel containers and distribution system. One of its leading characteristics is the entire elimination of hand labor from the transfer of liquid fuel from the container to the motor. Inert gas is admitted to the container under sufficient pressure to force the fuel through distributing pipes to any point in the works. The fuel pipes are surrounded by a casing, and in the annular space between them, a supply of inert gas under pressure is constantly maintained. Inert gas fills also the space between the double walls of the container, the outer wall of which is provided with fusible plugs. Diffusion guards properly located prevent the entrance of air into the container in case of rupture of any part of the piping system.

In connection with the question of fire prevention, we may refer briefly to a new chemical fire extinguisher especially adapted for combating fires in inflamable liquids. Water, it is well known, serves only to increase a fire in petroleum products, although it is effective against alcohol fires. Exclusion of air is the only means of effectively extinguishing an incipient blaze in gasoline, benzine or oil. In the method originated by Laurent, recently subjected to extensive tests by the Prussian Fire Protection Bureau, the agent employed is foam. A solution of sodium carbonate mixed with foam-producing substances, and a solution of alum, combined in equal parts, produce, without precipitation of any solid, a thick, yellowish-white foam, which can be pumped and sprayed as effectively as water. A mixture of one litre (0.264 gallon) of each of the solutions produces 15 litres (3.96 gal. of foam weighing 140 grammes per litre (18.6 ounces per gallon). Sprayed on a burning liquid, the foam, as it accumulates, spreads gradually over the whole burning surface, effectively shutting out the air and thus extinguishing the fire.

The tests referred to above have demonstrated that the foam has no deleterious effects on the fuel. It remains intact on the surface of liquids for comparatively long periods; on water, for example, the loss in 20 minutes is only 8 per cent, and on benzine, 28 per cent.

As to its efficiency in extinguishing fires, 2 typical results of the tests may be quoted. A fierce blaze in a tank of benzine 40.35 sq. ft. in area and 20 in. deep, was extinguished in 78 sec. In another case, with a larger expenditure of chemicals, only 13 seconds was required to quench a fire in another tank 6.56 ft. in diameter and 8.5 ft. deep.

There are two kinds of men who do big things. The first is the man who is born with the knack of aggressive leadership which he displays from boyhood; the second is the naturally backward man who, realizing his handicap of disposition, sets a goal for himself and pushes toward it with desparate determination. Of course the second has to work much harder than the first but often accomplishes just as much.—Mahin Messenger.



Power Apparatus

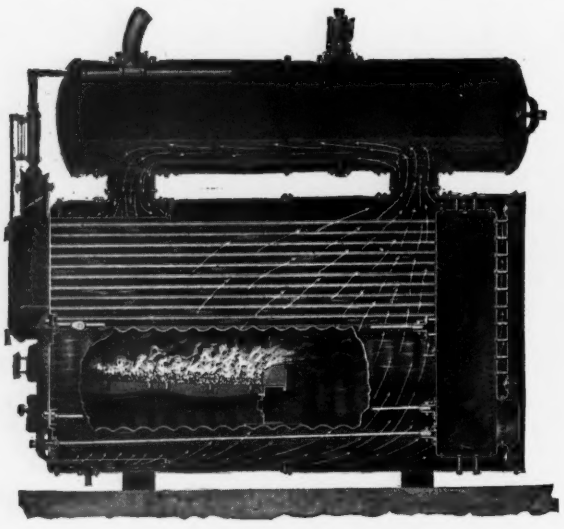
In Shop and Market

New Ideas in Making, Buying and Selling

ROBB-BRADY SCOTCH BOILER

THE Robb-Brady Scotch boiler is a modification of the well-known standard Scotch marine boiler. It differs from the Scotch marine type in that the water and steam space, usually all in one shell, is divided into 2 separate chambers, the upper drum forming the steam space, while the lower shell above the 2 furnaces is entirely filled with tubes.

As will be noted from the accompanying illustration, the combustion chamber is cylindrical and of a diameter nearly equal to that of the larger shell. Because of the cylindrical shape and the absence of the usual flat top, only short screwed stays are necessary, and the usual longitudinal or through stay rods are not required in the large shell since it is entirely filled with tubes. The small diameters of the 2 shells and the simplicity of staying greatly lessen the cost of construction.



THE ROBB-BRADY SCOTCH BOILER

Positive and rapid circulation is obtained by compelling the hot water from the steam drum to flow down the front neck and around the shell through the annular space provided for this purpose. The water from this annular space empties below the furnaces and replaces the hot water and steam which take the shortest path to the top, passing to the steam drum through the rear neck. The rapid circulation tends to increase the economy of the boiler by keeping the heating surfaces clean and in proper condition to transmit the heat freely, besides overcoming the inherent disadvantage of Scotch boilers. It also allows greater uniformity of expansion and eliminates the necessity of providing a special pump or other attachment to aid circulation. Being internally fired, no brick setting is necessary, thus avoiding all radiation losses and those due to infiltration of air through the setting.

The Robb-Brady Scotch Boiler is built by the Robb Engineering Co., South Framingham, Mass., and Amherst, Nova Scotia, and is adapted for both marine and stationary use, and complies in all respects with the requirements of the Massachusetts Board of Boiler rules.

AUTOMATIC PISTON PACKING

RECENTLY the H. W. Johns-Manville Co., of New York, secured control of the American rights to the well known English packing called Sea Rings.

Steam economizers, condensing plants, the more perfect combustion of fuel in furnaces, and the compounding of engines, with many other vital questions in modern manufacturing industries, have received careful attention at the hands of experts, each in their particular sphere. Until late years, however, little or nothing has been attempted in an effort to obviate the waste of power resulting from the packing of a gland or stuffingbox, and practically no change has taken place in the form or style of gland and stuffingbox since they were introduced. The amount of power consumed and the waste energy expended by means of placing soft packings in the stuffingbox to prevent leakage, whether of steam or liquid, is in some cases so great, more especially in the smaller machines, that there is a larger percentage of the total energy necessary to drive the engine, consumed in overcoming friction at that point. This is an item of considerable importance even in the case of the most powerful machines, as every ounce of steam entering an engine means coal consumed which should produce a corresponding amount of effective work.

FIG. I. J-M SEA RINGS

J. M. Sea Rings are moulded of a laminated material (asbestos, flax or duck) in the form of a wedge, with its thin edge turned inwards. There is a hollow space in every ring, between the lip and the heel of the ring, into which the steam follows, so that the steam itself, not the gland pressure, makes the packing pressure tight.

The mechanical correctness of the construction of J. M. Sea Rings is due to the principle upon which the hydraulic cup leather is worked, with the result that no one cup leather, as in hydraulic work, takes the whole strain, but it is divided up into 3, 4 or more rings, each taking its share in the work of keeping back the liquid pressure from leaking out to the atmosphere. The material is in laminae or fine layers. It produces the same strength as the bundle of sticks used in our youthful days. This fact, plus the following one, means naturally long life and resistance to wear. There are 2 classes of pressure in every working gland or stuffingbox; one is the tendency of the liquid pressure

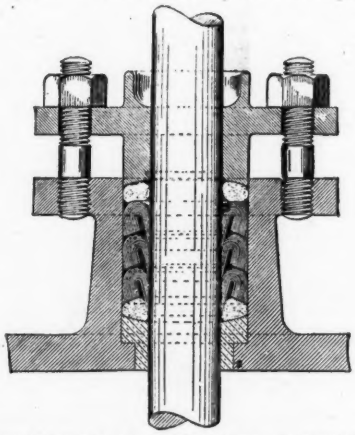


FIG. 2. APPLICATION OF AUTOMATIC PACKING TO GLAND

to leak out to the atmosphere in direct proportion to the extent of that pressure, and the other the necessary holding and tightening of the substance put in the stuffingbox to prevent leakage, that is to say, the screw pressure or gland pressure on the packing itself.

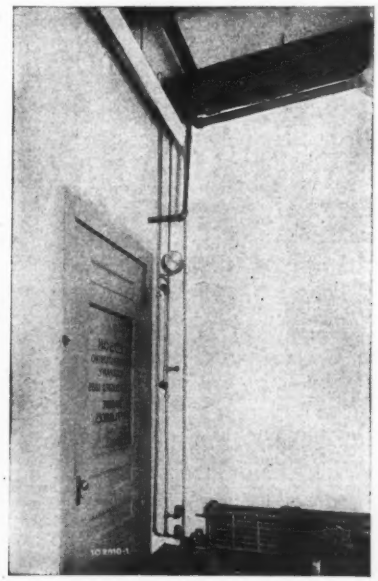
With J. M. Sea Rings these 2 pressures are separated entirely, the fluid pressure getting behind the long taper tongues and pushing them onto the rod; the outer wall or periphery, taking the whole screw pressure or physical pressure and the long taper tongues acting exactly as the points on a railway line, shunting the fluid pressure back and afterwards onto the rod.

J. M. Sea Rings stand 600 deg. Fahrenheit superheat; work just as well on horizontal as on vertical rods, as satisfactory for steam hammers, air compressors or for any other purpose; but are particularly adapted for pumps of all kinds.

RADIATOR RETURNS LIFTED THIRTEEN FEET

ILLUSTRATED by the accompanying cut is the method employed to overcome a difficult situation which arose in connection with the remodelling of an old heating system. The original heating outfit consisted of a 1-pipe system to which were attached unusually long radiators of the wall type. The building is six stories in height with no basement and steam is obtained from the boiler of an adjacent building. Most of the ground floor is of concrete, and this was put in after the heating pipes had been laid, entirely surrounding the latter. Practically no provision for expansion was made with the natural result that cracks appeared in the floor and leaks developed in the piping. To add to the difficulty of the situation tons of steel were stored on the concrete floor, making it impossible to get at the pipes without undue expense.

It was finally decided to replace the 1-pipe installation by a 2-pipe vacuum system. The only available place for the returns was upon the main floor ceiling, a distance of 13 ft. above the main floor radiator discharge connections. The returns from the



LIFTING RADIATOR RETURNS THIRTEEN FEET

ground floor radiators run vertically upward to the main return pipe, and at the discharge end of each radiator a Webster water seal motor serves to prevent the passage of steam into the return line and consequent breaking of the vacuum caused by the pump. In spite of the unusually high lift involved, this arrangement has worked satisfactorily with a vacuum at the pump of from 10 to 15 in.

CHANGES IN THE L. S. STARRETT CO. ORGANIZATION

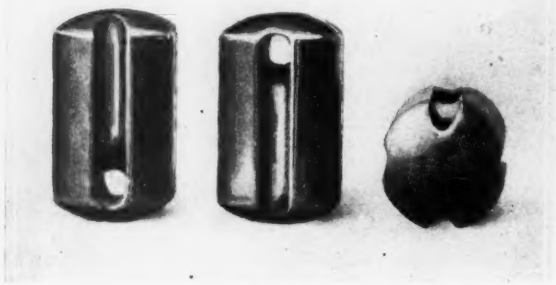
THE L. S. Starrett Co., which has one of the largest manufacturing establishments of fine mechanical tools in the world, has recently increased its capital stock to $3,500,000, of which $1,500,000 is to be 6 per cent cumulative preferred stock and $2,000,000 common stock.

The officers of the company are: L. S. Starrett, president; F. A. Ball, vice president; F. E. Wing, treasurer and secretary; W. G. Nims, assistant treasurer; with a board of 9 directors, consisting of the officers named and M. B. Waterman, Augustus P. Loring, John A. McGregor, J. H. Drury and W. B. McSkimmon. The last 4 named are officers of the Union Twist Drill Co., the second largest machine factory in Athol. The Union Twist Drill Co. becomes a stockholder of The L. S. Starrett Co. and as such has representation on the board of directors, which is increased from 5 to 9; L. S. Starrett, who started the business in 1880 and has conducted it ever since, continues in active control.

WESTINGHOUSE PORCELAIN STRAIN INSULATOR

THERE are many conditions for which properly designed porcelain strain insulators are admirably suited. They are largely used in guy wires by street railway and by electric power companies, and groups in series are used at dead ends to take the strain off and to insulate the line wires.

Westinghouse Form P 2 porcelain strain insulators are made of a grade of porcelain much superior to that ordinarily used for such appliances. The glaze is a dark brown so that the insulators do not readily attract attention in the air. Sharp corners that would be apt to chip have been avoided and the shape of the grooves is such that the wires lie naturally in them.



WESTINGHOUSE P_2 PORCELAIN STRAIN INSULATORS

Three sizes are made, 2⅜ in. to 3¼ in. diameter and 3⅛ to 5¼ in. long. The break down voltage when the insulators are dry, is about 20,000 volts for each of 3 sizes. The approximate ultimate tensile strengths of the insulators, when wired up in guy wires, are respectively 14,000, 16,000 and 23,000 lb.

Even if such an insulator fails either because of excessive stress or through accident, the wires that it carries cannot drop, because they are interlinked. Two insulators are often installed in series; then if one breaks, the other provides insulation; it is quite improbable that both will break at the same time.

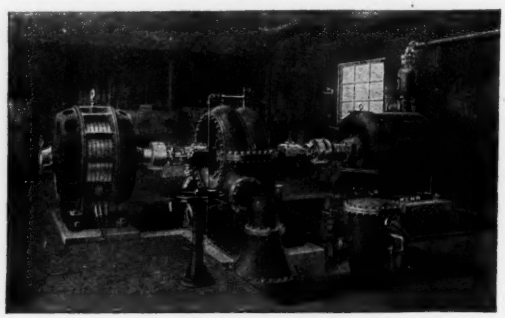
NOVEL METHOD OF OVERCOMING PEAK LOAD TROUBLES

USERS of electric power are sometimes compelled to buy on a "peak load" basis; that is, not exceeding a fixed current consumption at any time during the year, but paying constantly for that fixed maximum regardless of how much current is used. On this basis of payment, it is evident that continually running close to the specified limit or, vice-versa, keeping the current consumption low at the time of greatest load is advantageous. The former procedure is impossible in many manufacturing processes, as it is in lighting and street railway work; the latter is usually attempted by the use of storage batteries.

Those who have studied this peak load problem will be interested in a novel solution which has been quite successful in the municipal lighting and waterworks plant of the city of Lachine, Canada. In this instance the low cost and satisfactory operation of a 400-hp. steam-turbine unit is utilized in effecting the economy. In the Lachine plant, a 14-in., 2-stage, double-suction turbine pump with a capacity of 6,000,000 gal. in 24 hr. is utilized to provide water supply and fire protection for the city, the water pressure being ordinarily 80 lb. per sq. in. and for fire 120 lb. per sq. in.

Current is purchased by the year on a basis which is all right for lighting the city and for pumping at all times of the year except the 3 winter months during which the lighting load is greatest. It was figured that operating the pump by steam for 4 or 5 hr. a day during that period could be made less expensive than buying sufficient electric current to operate entirely by electricity. As further advantages of an auxiliary steam installation, the insurance rate on the pumping station could be reduced and the city could be better lighted during fall evenings without incurring unreasonable additional expense.

Is was therefore decided to arrange the pump for operation by a 400-hp. induction motor the greater part



PUMP ARRANGED FOR MOTOR OR STEAM TURBINE DRIVE

of the time, but by a steam turbine during the peaks in the lighting load in winter, and in case of accident to the electric line.

The installation, furnished by the John McDougall Caledonian Iron Wks., Montreal, is shown in the accompanying illustration. The pump, of Worthington make, runs at 900 r.p.m. and is direct connected to an Allis-Chalmers motor on one side and a 400-hp., 4-stage Kerr turbine on the other. Either driving unit can be thrown into or out of use instantly by means of clutches on the shaft.

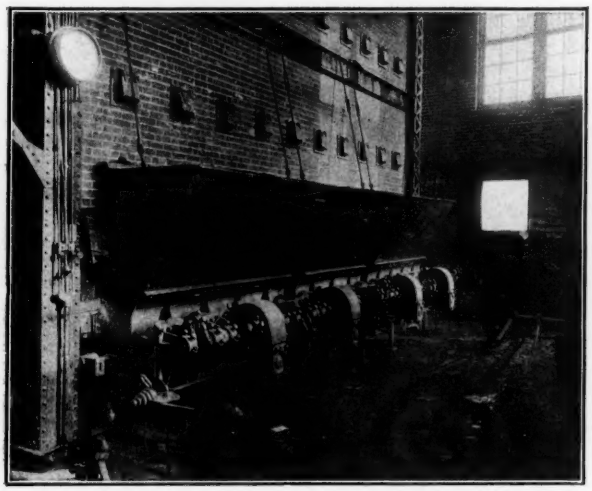
INSTALLATION OF LARGE STOKERS

HARTFORD Electric Light Co. of Hartford, Conn., has recently completed the installation at its Dutch Point station of what are, as far as is known, the largest automatic stokers ever built. These are 2 14-retort Taylor Gravity Underfeed Stokers, which were built by the American Ship Windlass Co. of Providence, R. I., and fire 2 1250 hp. Bigelow-Hornsby boilers. Two other boilers of the same size, which have been in operation for some time fired by hand are also being equipped with Taylor stokers, so that the total horsepower of the stoker battery will be 5000 boiler hp. divided into only 4 units.

In this type of stoker the coal, which is fed into a hopper on the boiler front, is pushed out underneath the fire by means of automatic rams and at the same time is carried downward by the steep slope of the grate. The forced draft is supplied at a pressure of about 4 in. by 3 Sturtevant blowers, engine driven, which discharge into ducts supplying all the boilers.

Because of the underfeeding feature, smokelessness is a peculiar attribute of these stokers, the hydrocarbons being distilled off and passing through the hottest part of the fire before the green coal itself arrives at the temperature of ignition. This coking process together with the automatic air control which insures sufficient oxygen for combustion at all loads results in smokeless combustion and at the same time a very high boiler efficiency.

Extremely large overloads have been carried on stokers of this type and it will be interesting to note what will be accomplished in this line in the present installation. Should these boilers be able to sustain a 200 per cent rating, the truly remarkable condition would exist of a single stoker producing 2500 boiler



1250-HP. STOKERS IN HARTFORD ELECTRIC LIGHT CO.'S PLANT

hp. in one unit. The exceedingly large size of these units is due to the desire on the part of the management to bring about an economy of labor as well as economy of space. Instead of 12 men per 24 hr. to a battery of 2500 hp. as was the case with hand firing, the stokers handle the same boiler capacity with 3 men per day, one man for each shift of 8 hr. Concentration of power was another factor sought and it is also believed that there will be an added economy in operation because of less radiation.

JOHN G. OULD

JOHN GEORGE OULD died at his home, 1348 47th Street, Broolyn, N. Y., on the evening of Dec. 21, from kidney trouble. Mr. Ould had been in poor health for some time. His last appearance was at the annual meeting of the A. S. M. E. He attended the reception in the Hotel Astor on Thursday evening, Dec. 7 and also attended the morning session on Friday the 8th. He was then feeling so badly he just mustered up sufficient strength to return home and took to his bed and died.

Mr. Ould was born on April 2, 1863 in Falmouth, Cornwall, England. He was graduated from private schools in England and later in life from the night classes in Kensington Science and Art School 3-year course. He also took a 2-year course in the New York Y. M. C. A., 2 years in Pratt Institute and 3 years in the Polytechnic Institute of Brooklyn. He also had a diploma from the I. C. S. as Electrical Engineer.

In his youth he served as an indentured apprentice in the shops of England and then served 7 years as a marine engineer on ocean going vessels. In 1890 he came to New York and settled. For some time he was chief engineer of the Bulkenhayn adjoining the Hotel Savoy; for the past 14 years he has been superintendent and chief engineer of the Polhemus Memorial Clinic, Brooklyn, N. Y., taking that position in February 1897.

Mr. Ould was a member of the Philharmonic Society of Brooklyn, Associate member of the A. S. M. E. and corporate member of the Brooklyn Engineers' Club, and at the time of his death was vice-president and commissioner of apprentice training of the Institute of Operating Engineers, he being one of the charter members of the latter.

Mr. Ould was a man of the highest merit in his public and private life and impressed his personality upon every one he met. He will be greatly missed by his brother engineers and associates in society work.

NEWS NOTES

ANNOUNCEMENT IS MADE of the consolidation of Williamson Bros. Co., of Philadelphia, the American Ship Windlass Co., and Taylor Stoker Co., formerly of Providence, R. I., under the title American Engineering Co., with works and offices at Philadelphia, Pa. The American Ship Windlass Co. was founded about 53 years ago, and is the oldest builder of ship windlasses, capstans and so forth, and for many years was the only patentee of ship windlass machinery. The Taylor stoker was originally built in the American Company's plant at Providence, but as time went on business increased so that the marine business was transferred to Philadelphia to give room for both branches of the work.

The first steps in the consolidation were taken when, in 1906, Williamson Bros. Co., who had been pioneers in steering engines, purchased control of the American Ship Windlass Co., with the intention of gradually combining the business of the 2 concerns in the line of marine products. As it was practically impossible to increase the capacity of the Providence plant without entirely rebuilding, the decision was made to build additional shops at Philadelphia and consolidate all the departments of the business under one head at that point.

At present the plant consists of a foundry approximating 100,000 pounds capacity a day, with facilities for handling a large amount of jobbing work, machine shops covering 80 by 500 ft., pattern shop, storage buildings for patterns and finished products, blacksmith shop and central building for office and engineering department.

MCINTOSH & SEYMOUR CO. has been incorporated with capital stock of $600,000 and will take over the business of McIntosh, Seymour & Co., of Auburn, N. Y. Officers of the company are: President, J. Alward Seymour; vice president, Wm. B. Morrison; treasurer, Wm. I. Ferrey; directors, Harte Cooke, Earl A. Merrill. John E. McIntosh severs his connection with the business.

BOOK REVIEWS

PRACTICAL APPLIED ELECTRICITY, by David Penn Moreton, Chicago, 1911, 438 pages, 5 by 7 inches, 330 illustrations, and tables, full leather binding, price $2.

Professor Moreton has utilized his knowledge of the subject of electricity, and his knowledge of the best method of imparting the information acquired by his experience at Armour Institute and elsewhere, to lay before his readers the principles and practice of electricity in clear and usable form. Starting with the electric circuit and the units for measurement of current, voltage and resistance, he shows the method of

calculating resistance, for simple, series and compound circuits, the action of primary batteries, the scientific explanation of magnetism and electro-magnets, the action of electro-magnetic induction and its application to the dynamo and motor, the method of operation of electrical instruments to measure current and voltage, the details of construction of direct current machinery, and the method of winding direct current armatures, the principles of storage batteries, their application and management, methods of distributing electric current, and of operating machinery, the troubles that are encountered in dynamos and how to remedy them, the apparatus used in electric lighting by arc lamps and incandescents and the newer forms, methods of installing electric wiring, and of deciding on the size wire to be used, the properties of alternating current and how they modify the direct-current formula, the action of alternating-current machinery, and the use of logarithms for making calculations in regard to alternating-current circuits. Throughout the work Professor Moreton has kept in mind the men who are to use it, and he has avoided all difficult mathematics, the most abstruse being only a simple formula or equation which can be handled even without knowledge of algebra. His explanations are in all ways clear, and his illustrations from practice deal with the latest types of machinery and the latest methods of correct operation. The book is one which can be heartily commended to all readers.

A BULLETIN OF THE BUREAU OF MINES contains a chapter by J. K. Clement and L. H. Adams on "Effective Temperatures for Water Gas Generation."

The results presented show that a high rate of gasification combined with a high percentage of carbon monoxide and a low percentage of carbon dioxide and water requires a high temperature in the fuel bed.

The higher the temperature, the better will be the quality of the gas and the greater the capacity of the producer.

The use of large amounts of steam is inconsistent with the realization of high temperature, and is, therefore, to be avoided.

Although these investigations were undertaken primarily to determine the conditions governing the formation of producer gas, the results have an important bearing on the water gas process.

They show that although with very low rates of steam supply the decomposition of the steam may be complete at 2000 deg. F., with higher rates of steam supply, such as are desirable in practice, a much higher temperature, 2400 or 2500 deg. F. is required to obtain complete decomposition. The highest efficiency will be obtained by raising the temperature of the bed during the blast as high as is possible without injury to the producer. As the bed cools during the run with steam, the steam should be gradually reduced, and when the temperature has dropped to 2000 deg. F. the steam should be shut off.

Copies of the Bulletin may be obtained by addressing the director of the Bureau of Mines, Washington, D. C.

FROM THE PRESS of John Wiley & Sons, New York, have come recently 3 books of importance to engineers. The first of these is the Eighth Edition, revised, rewritten and enlarged, of Kent's Mechanical Engineer's Pocket Book. This now has 1500 pages and has been brought down to date, set in new type, and with tables so arranged as to be of greatest convenience. It is a complete resume of engineering knowledge in the mechanical field.

The second book is Steam Power Plant Engineering by Prof. G. F. Gebhardt, published in the third edition, and containing probably the most comprehensive treatment of the subject that has been compiled.

The third book is one intended for the use of those starting on the study of electricity. It is called Elements of Electricity, by W. H. Timbie, and is especially intended as a text book in a course of Industrial Electricity, given at Pratt Institute, Brooklyn. It is the result of years of experience in teaching electricity to day and evening students, starting with a basis of a knowledge of arithmetic and the simplest of algebraic equations. It is aimed to give, in the easiest and briefest way possible, a good working knowledge of electricity, avoiding on the one hand a smattering which will be misleading, and on the other an itricate treatment which will be confusing.

CATALOG NOTES

THE ECONOMY ELEVATOR Guide Lubricator, The Lubricator That Lubricates, is the title of an attractive catalog just issued by the Peterson Engineering Co., lubrication engineers, Hudson Terminal Building, New York City. The catalog describes a new method of lubricating elevator guides in which a thin strip of grease is applied exactly where the shoes bear on the rails and for every trip of the car. Several different types are described suitable for steel and wooden rails and also for counter weight guides. Interesting data are given of tests made on elevators equipped with the Economy lubricator. For instance, it is stated that in the 168th Street Station of the New York Subway, the Economy lubricator reduced the grease consumption from 480 ounces to 30 ounces per month. An analysis of the cost of lubricating the elevators in the Washington Monument, by means of the Economy lubricator, is also included. Copies of this catalog may be had by addressing the manufacturer at the above address.

BULLETIN NO. 20, dealing with the economy improvements and operating conveniences of Kerr Turbo-Blowers and Turbo-Pumps, particularly in gas plant service, has just been issued by the Kerr Turbine Co., Wellsville, N. Y. This bulletin contains interesting comparisons with other driving methods for the same work and illustrates a number of installations.

BULLETIN NO. 104, issued by the Sterling Machine Co., of Norwich, Conn., describes the improved Sterling mechanical lubricator for general internal lubrication. Cross section and detail illustrations show the construction and operation, and other views show the general appearance and method of attachment.

FROM THE OIL CITY BOILER WORKS, of Oil City, Pa., comes a new booklet giving a brief description of the Geary Water-Tube Boiler, which is constructed of wrought steel throughout and is of the horizontal inclined water-tube type. Full illustration of the details is given in the booklet, also description of the construction and illustrations of the settings with different types of furnaces.

DETAILS OF THE TYPE H direct-current motors and generators, manufactured by the Ideal Electric & Mfg. Co., of Mansfield, Ohio, are described in its bulletin No. 1011. The bulletin also gives test curves and characteristics and shows details of construction. Novel features are the method of attaching the pole piece to the frame in order to keep laminations in place and distribute the lines of magnetic

flux, also the method of connecting the brush holder to the stud to prevent short circuiting and leakage to the ground.

A NEW RECORDING gas calorimeter known as the Smith Recording is being manufactured by the Lexington Instrument Works, of Lexington, Ohio. It is an apparatus for making a continuous record of the heat value of gas and was designed primarily to record the value of producer gas. It requires practically no attention and gives readings automatically corrected to the standards of 60 deg. F. and 30 in. barometer. Descriptive matter may be had by addressing the manufacturers.

IN A 94-PAGE book bearing the title Heating & Ventilating, the Green Fuel Economizer Co., of Matteawan, N. Y., has brought together the information required for the designing and proportioning of hot-blast outfits for heating, ventilating, drying, etc. The book contains some 2 or 3 dozen tables of temperatures required in rooms for various purposes; heat transmission through building materials; heat given off by occupants and by lights; standard sizes of hot-blast heaters; frictional resistance of air washers; relative humidities; humidities and temperatures throughout the United States; amounts of air required for ventilation; equivalent air pressures; velocities and horse powers; total weight of air at various barometers and temperatures; pressure and power consumed in friction; speed capacity and power of steel plate fans; friction of air through hot blast coils, etc. The text takes up not only the usual details relating to the construction of fans, heaters, and heating and ventilating systems, but also the calculation and designing of piping systems, giving for the latter 2 methods differing somewhat, covering the resistance of sheet-iron pipes and of angles, bends, branches, grills or registers, etc. There is also a chapter on the loss of head of air flowing through orifices and equivalent orifices, in which is presented a method of combining the resistances of ducts in parallel and series connections analogous to the Ohm's and Kirchoff's laws for electrical circuits. Another chapter gives the result of an extensive series of tests upon Green's Positiv-flo steam heating coils, by means of which heaters of suitable sizes may be selected for any given duty. The general illustrations of the book include not only views of buildings equipped with heating and ventilating apparatus built by the Green Fuel Economizer Co., but also detailed plans, elevations and "ghost" views showing the actual arrangement of the fans, heaters, piping, outlets, etc. Copies of this book will be sent upon requests to engineers and others concerned with the purchase, design, or operation of heating plants.

ONE OF THE NEW devices in the heating line is the Vento cast-iron hot blast heater made by the American Blower Co., of Detroit, Mich. This consists of sections of the common pin type heater put together with nipples and arranged in banks in the same way that pipe coils are arranged. The sections are tested for 100 lb. pressure to the square inch before assembling, and are recommended for use on pressures not exceeding 40 lb. Full description of these sections and the method of using them in heating of buildings is given in bulletin 306, issued by the American Blower Co., which gives also dimensions of the sections, combinations which may be used and the method of installing, as well as showing views of installations which are in actual service.

THE GENERAL ELECTRIC CO. is just issuing its 1912 catalogue of Electric Fans, bulletin 4895. The publication is an attractive one printed in colors, and contains descriptions and illustrations of the fans manufactured by that company for use in the home, office and public places. The line of fans comprises those suitable for use on desk or table, and which are manufactured with fan diameters of 8, 12 and 16 in. All these are convertible without the use of tools or additional parts, so that any one may be used on a horizontal surface or attached to a wall. They are made in 2 styles; fixed and oscillating. The publication contains also illustrations and descriptions of the ceiling and column fans manufactured by the Company, and a line of supply parts for these.

AN ATTRACTIVE PUBLICATION, No. 4908, just issued by the General Electric Co., is devoted to the subject of the Lighting of Hotels, Cafes and Clubs. It contains illustrations of many hotels, restaurants, etc., with the number and kind of lamps used in lighting. Also the history of the development of the incandescent lamp, and cost of operating drawn wire Mazda lamps.

BULLETIN 4902, recently issued by the General Electric Co., lists direct-current switchboards of 125 and 250 volts for controlling 3-wire generators up to 200 kw. capacity, and 2-wire or 3-wire feeder circuits up to 1200 amperes. These panels are so designed that the appearance of both the front and back of the switchboard will be neat and uniform. The bulletin contains connection and dimension diagrams of various panels.

ROCK DRILLS, Bulletin Form 4108, issued by Ingersoll-Rand Co., 11 Broadway, New York City. Catalog of 4 pages, descriptive of the B-104 Sergeant Rock Drill, which is a machine specially adapted for driving small headings, stoping or similar work requiring a light and small, but powerful machine. This drill has a 2½-in. diam. cylinder and will drill a 1 to 1½-in. diameter hole to a depth of 20 in. without change of steel. Bulletin shows duplicate parts of the drill and also gives full specifications and details.

THE REQUIREMENTS OF A BALL Bearing Grease, by Herbert L. Towle, discusses the essential feature of such a grease, and tells how these features may be obtained. It also explains the properties of Hess-Bright ball bearing grease, which is made particularly for such purpose. The pamphlet may be had from the Hess-Bright Mfg. Co., Philadelphia, Pa.

DEANE STEAM PUMP CO., Holyoke, Mass., in a new bulletin, D-205, gives an extensive discussion of the construction of its triplex power pumps of the vertical, double acting type. It explains the advantages of the triplex machine over other forms of power pumps, principal among which is that the combined discharge from the cylinders is practically uniform in quantity and pressure. The special features of design that are the outcome of this company's 40 yr. specialization in the building of power pumping machinery, will be found of particular interest. The simplicity, durability, accessibility and solidity of the Deane triplex power pump are points that are specially emphasized. The pumps listed range in size of cylinders from 2 by 3 in. to 13 by 12 in., and in capacities from 11½ to 2475 gal. a min. Some 9 different styles of these pumps are illustrated and table of dimensions, capacities, speeds, etc., are given of each. The pumps are arranged for belt or gear drive from any power source.

MOST INTERESTING DESCRIPTIONS and illustrations on the Bowser Oil Filtration and Circulating Systems, made by S. F. Bowser & Co., of Fort

Wayne, Indiana, are given in a catalog, which shows the application of the system to the plants of the Curtis Publishing Co. at Philadelphia, the John Hoberg Co.'s paper mill at Green Bay, Wis., and others. The catalog shows also the details of the Bowser filter, including the Bowser filter section, the multiple bowl oil fountain, the parts of the circulating system and the devices used in the Bowser oil storage system.

FROM THE HOHMANN & MAURER division of the Taylor Instrument Co., at Rochester, N. Y., comes a handsome and attractive catalog on recording and index thermometers. This shows the method of installing the bulbs in smoke stacks, air ducts, steam and water pipes, heating tanks, and wooden water tanks. It shows also the details of the recording mechanism and the method of making the record chart. It will be found instructive and attractive.

INGERSOLL-RAND CO., 11 Broadway, New York City, in its catalog Form 4003—Bulletin of 16 pages, on Little Giant Rock Drills, shows the machine in section and gives views of machines at work on the Panama Canal. The distinctive characteristic of this tappet rock drill is the positive character of its valve movement; as there is direct mechanical connection between valve and drill piston, when steam or air is admitted to the cylinder, the piston must move; and when the piston moves, the valve must be thrown, so that the operation of the drill is certain. The valve movement consists of 3 pieces: a valve, a rocker and a rocker pin. The rocker turns on the rocker pin and is so arranged that one or the other of its lower members is always in contact with the piston; its upper member, ending in a globular shape, projects into the valve. When the piston moves, a curved surface slides under one of the rocker contacts, pushing the rocker upward and swinging the valve in the same direction as the piston is moving. On the reverse travel of the piston, this series of movements is exactly reversed. The throw of the valve covers and uncovers the supply of exhaust ports. Catalog gives descriptive table of Little Giant Drills showing sizes and principal dimensions.

TRADE NOTES

THE VILTER MFG. CO., with offices at 927 Clinton St., Milwaukee, Wis., report the following list of recent sales: Arkansas Short Leaf Lumber Co., Pine Bluff, Ark., 24 by 42-in. Corliss engine; Hoeschen-Wentzler Brewg. Co., Saskatoon, Can., 35-ton refrigerating plant and 14 by 36-in. Corliss engine; Konrad Schreider Brewing Co., Sheboygan, Wis., 20 by 42-in. Corliss engine for direct connection to electric generator; Parker, Webb & Co., Packers, Detroit, Mich., 12240 ft. 2-in. w. i. pipe, 2480 ft. 2-in. expansion piping; Gridley Dairy Co., Milwaukee, Wis., 110-ton refrigerating plant and 16 by 30 by 36-in. tandem compound Corliss engine; Washington Market Co., Washington, D. C., 75-ton refrigerating plant; Anheuser-Busch Brewing Association, for New York, 80-ton block ice plant, for St. Louis, Mo., 6160 ft. 2-in. piping; Hochgreve Brewing Co., Green Bay, Wis., 60-ton refrigerating machine, high pressure side and 16 by 30-in., Corliss engine; M. Burkhardt Brewing Co., Akron, O., 10-coils atmosphere ammonia condenser; Citizens Ice Co., San Antonio, Tex., 185-ton refrigerating machine with 24 by 48-in. Corliss engine; Hussa Brewing Co., Bangor, Wis., 60-ton refrigerating plant, 16 by 30-in. Corliss engine; Holihan Bros., Liquor Dealers, Lawrence, Mass., 35-ton refrigerating plant and 12 by 30-in. Corliss engine; Jos. Schlitz Brewing Co., Milwaukee, Wis., 8750 ft. 2-in. expansion piping; Winnfield Ice & C. S. Co., Winnfield, La., 55-ton refrigerating machine and 15 by 30-in. Corliss engine; Wm. Ulmer Brewing Co., Brooklyn, N. Y., 105-ton refrigerating machine and 20 by 42-in. Corliss engine; Susquehanna Brewg. Co., Nanticoke, Pa., 60-ton refrigerating machine and 16 by 36-in. Corliss engine; Excelsior Hygienic Ice Co., New York, 200-ton can ice tanks; Sterr Bros., Lomira, Wis., 23-ton refrigerating plant and 10 by 30-in. Corliss engine.

THE ATLANTIC HYGIENIC Ice Company of Brooklyn, N. Y., recently purchased a 14-in. Swartwout Horizontal Oil Separator, made by the Ohio Blower Company, Cleveland, Ohio. This company reports other recent sales of Swartwout products as follows: Chattanooga Steam Laundry Co.. Chattanooga, Tenn., 1 3½-in. horizontal oil separator; Jones & Laughlin Steel Co., Pittsburgh, Pa., 1 10-in galvanized iron exhaust head; John Bouchard & Son Co., Nashville, Tenn., 1 8-in. horizontal oil separator; North Shore Electric Co., Blue Island, Ill., 1 8-in. horizontal oil separator; W. K. Mitchell & Co., Philadelphia, Pa., 1 4-in. vertical high pressure steam separator; Wisconsin Steel Co., Nashwauk, Minn., 1 6-in. vertical high pressure steam separator; F. W. Lamb Co., Chicago, Ill., 1 10-in. and 1 5-in. cast-iron exhaust heads; F. W. F. Carlisle Co., Saginaw, Mich., 1 6-in. horizontal oil separator; Edible Products Co., Bayonne, N. J., 1 6-in. horizontal oil separator; Virginia Carolina Chem. Co., Birmingham, Ala., 2 5-in. cast-iron exhaust head and 2 3-in. vertical steam separators; Standard Steel Car Co., Butler, Pa., 1 12-in. cast-iron exhaust head; Keystone Rubber Wks. Co., Erie, Pa., 1 7-in. cast-iron exhaust head and 1 6-in. vertila steam separator.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

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POSITION WANTED—As chief engineer in some electric light and power plant. Have had 20 years' experience with both alternating and direct current. Am at present manager for an electric light and ice company. Desire a change to a plant of like character if possible. Can give best reference and can come at once. Address Box 199, Practical Engineer, Chicago, Ill. 1-15-1

POSITION WANTED—As chief engineer ot electric plant in some state institution. 17 years' experience with electric plant and water works. Can do own repair work. Sober and industrious. Middle west preferred. 42 years of age. Best references. Ready at once. L. C. Utley, Chapel Hill, N. C. 1-15-1

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